Total Maximum Daily Load Report for the South Fork Blue River Watershed

Final TMDL

August 08, 2017

Prepared for: U.S. Environmental Protection Agency Region

Prepared by: Indiana Department of Environmental Management

Table of Contents

Tables

Figures

1.0 EXECUTIVE SUMMARY

The South Fork Blue River Watershed (HUC 0514010406) is located in south central Indiana and drains a total of 130 square miles. The South Fork Blue River Watershed originates near New Pekin in south west Washington County, and then flows southwest, where it ultimately empties into the Blue River near Fredericksburg. Land use throughout the watershed is split between predominantly forested and agricultural land use. The South Fork Blue River is not a source of drinking water for any cities or towns.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) impaired waters list. A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs are composed of the sum of individual waste load allocations (WLAs) for regulated sources and load allocations (LAs) for sources that are not directly regulated. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

The South Fork Blue River Watershed TMDL was prioritized to be completed at this time based on local interest in addressing water quality, Indiana Department of Environmental Management (IDEM) interest in conducting baseline water quality monitoring for local planning, and a competitive Section 319 application from the local partners to develop a watershed management plan in conjunction with the IDEM sampling and TMDL development for streams impaired by *E. coli*, IBC, nutrients and sediment.

This TMDL has been developed for *Escherichia coli* (*E. coli*) in the South Fork Blue River watershed.

After IDEM identifies a waterbody as having impairment and places the waterbody on Indiana's Section 303(d) list of impaired waters, IDEM implements a sampling plan to determine the extent and the magnitude of the impairment. The next task is to reassess each waterbody using new sampling data and to examine the watershed as a whole. The reassessment data helps IDEM identify the area of concern for TMDL development. As a result of the reassessment for the South Fork Blue River watershed, the pollutants and the impaired segments for which TMDLs were developed differ from the pollutants and impaired segments appearing on the Draft 2014 Section 303(d) list for the following reason:

- Sampling performed by IDEM in 2014-2015 generated new water quality data that were not available at the time the Draft 2014 Section 303(d) list was developed.

Sampling data collected by IDEM in 2014-2015 at 21 sites were used for the TMDL analysis. The data indicates that 20 of the sample sites violated one or more of the Indiana Water Quality Standards.

Potential sources of *E. coli* in the watershed include both regulated point sources and nonpoint sources. Point sources such as waste water treatment plants (WWTPs) are regulated through the National Pollutant Discharge Elimination System (NPDES) Program. Nonpoint sources such as unregulated urban storm water, agricultural runoff, combined feeding operations (CFOs) and faulty and failing septic systems are also potential sources throughout the watershed.

Determining the specific reasons for high E. coli counts in any given waterbody is challenging. There are many potential sources and E. coli counts are inherently variable. Within the South Fork Blue River watershed, subwatersheds with higher agricultural landscape also have the highest average E. coli counts. It is therefore possible that land application of manure in these subwatersheds is contributing to the elevated E. coli counts. However, other factors could also explain this correlation, such as failing septic systems along with small unregulated farming operations that allow livestock to have direct access to streams, these subwatersheds also tend to experience lower flows and thus have less dilution. Specific sources of E. coli to each impaired waterbody should be further evaluated during follow-up implementation activities.

Two subwatersheds in the South Fork Blue River watershed have impaired biotic communities (IBC). Biological communities include fish and aquatic invertebrates, such as insects. These in-stream organisms are indicators of the cumulative effects of activities that affect water quality conditions over time. An IBC listing on Indiana's 303(d) list suggests that one or more of the aquatic biological communities is unhealthy as determined by IDEM's monitoring data. IBC is not a source of impairment but a symptom of other sources. Degradation in local stream habitat has been determined to be driving the biological community impairment (IBC) and target exceedances of pollutants that might be contributing to the impairment have not been documented. Therefore, this TMDL will not be addressing the six AUIDs that are impaired for IBC.

An important step in the TMDL process is the allocation of the allowable loads to individual point sources as well as sources that are not directly regulated. The South Fork Blue River watershed TMDL includes these allocations, which are presented for each of the 101 Assessment Unit IDs (AUIDs) located in the six 12-digit hydrologic unit code (HUC) sub watersheds.

There are two NPDES permitted Waste Water Treatment Plants (WWTPs) located in the South Fork Blue River watershed. Of these facilities, The Palmyra WWTP has been found to be in violation of their permit limits for *E. coli* in the past 5 years. Although this facility has been found to be in violation of their permit limits, the majority of the time discharge effluent from these facilities meets water quality standards.

There are several types of nonpoint sources located in the South Fork Blue River watershed, including unregulated livestock operations, agricultural row crop land use, straight pipes, leaking or failing septic systems, wildlife, and erosion. Of these, agricultural row crop land use and erosion are found most often in the subwatersheds with elevated levels of *E. coli*. Although Indiana does not have a permitting program for nonpoint sources, many nonpoint sources are addressed through voluntary programs intended to reduce pollutant loads, minimize flow, and improve water quality.

This TMDL report identifies which locations could most benefit from focus on implementation activities. It also provides recommendations on the types of implementation activities, including best management practices (BMPs) that key implementation partners in the South Fork Blue River watershed can consider to achieve the pollutant load reductions calculated for each sub watershed.

Public participation is an important and required component of the TMDL development process. The following public meetings and public comment periods have been held to further develop this project:

- Two Kickoff meetings were held at the Palmyra United Methodist Church and Pekin Shelter House on 11-18-2014 during which IDEM and Washington County SWCD described the TMDL program and provided a summary of the available data and the proposed modeling approach.

- On 7-12-2016, the South Fork-Blue River Watershed Project teamed up with the Indiana Department of Environmental Management (IDEM) to host a water monitoring demonstration. The event was held on Dutch Creek at the property of David and Theresa Gottbrath in Pekin IDEM staff were on site to explain and/or give demonstrations on their process for collecting water chemistry, fish through electrofishing techniques, and macroinvertebrates. Results were discussed for the 2014-2015 IDEM sampling of the watershed. The details of the partnership between the Washington County SWCD and IDEM were detailed as well. The Nature Conservancy, Purdue University, and Bellarmine University were also in attendance to share their projects within the watershed.

- One Draft TMDL meeting was held at the Palmyra Senior/Community Center on July 27, 2017 during which IDEM described the TMDL program and provided an overview of the draft TMDL results. A public comment period was from July 7, 2017 to August 7, 2017.

2.0 INTRODUCTION

This section of the Total Maximum Daily Load (TMDL) provides an overview of the South Fork Blue River watershed location and the regulatory requirements that have led to the development of this TMDL to address impairments in the South Fork Blue River watershed.

The South Fork Blue River Watershed TMDL was prioritized to be completed at this time based on local interest in addressing water quality, IDEM interest in conducting baseline water quality monitoring for local planning, and a competitive Section 319 application from the local partners to develop a watershed management plan in conjunction with the IDEM sampling and TMDL development for streams impaired by *E. coli*.

The South Fork Blue River watershed (HUC 0514010406) shown in Figure 1, is located in south central Indiana and drains a total of approximately 130 square miles. The South Fork Blue River watershed originates near New Pekin, and then flows southwest, where it ultimately empties into the Blue River near Fredericksburg. Land use throughout the watershed is split predominantly between forested areas and agricultural uses. The South Fork Blue River Watershed is not a source of drinking water for any cities or towns.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) regulations require that states develop TMDLs for waters on the Section 303(d) lists. USEPA defines a TMDL as the sum of the individual waste load allocations (WLA) for point sources and load allocations (LA) for nonpoint sources, and a margin of safety (MOS) that address the uncertainty in the analysis.

The overall goals and objectives of the TMDL study for the South Fork Blue River watershed are:

- Assess the water quality of the impaired waterbodies and identify key issues associated with the impairments and potential pollutant sources.
- Determine current loads of pollutants to the impaired waterbodies.
- Use the best available science and available data to determine the total maximum daily load the waterbodies can receive while fully supporting the impaired designated use(s).
- If current loads exceed the maximum allowable loads, determine the load reduction that is needed.
- Inform and involve the public throughout the project to ensure that key concerns are addressed and the best available information is used.
- Identify critical conditions that watershed stakeholders can use to identify critical areas
- Recommend activities for purposes of TMDL implementation.
- Submit a final TMDL report to the U.S. Environmental Protection Agency (USEPA) for review and approval.

Watershed stakeholders and partners can use the final approved TMDL report to craft a watershed management plan (WMP) that meets both USEPA's nine minimum elements under the CWA Section 319

Nonpoint Source Program, as well as the additional requirements under IDEM's WMP Checklist.

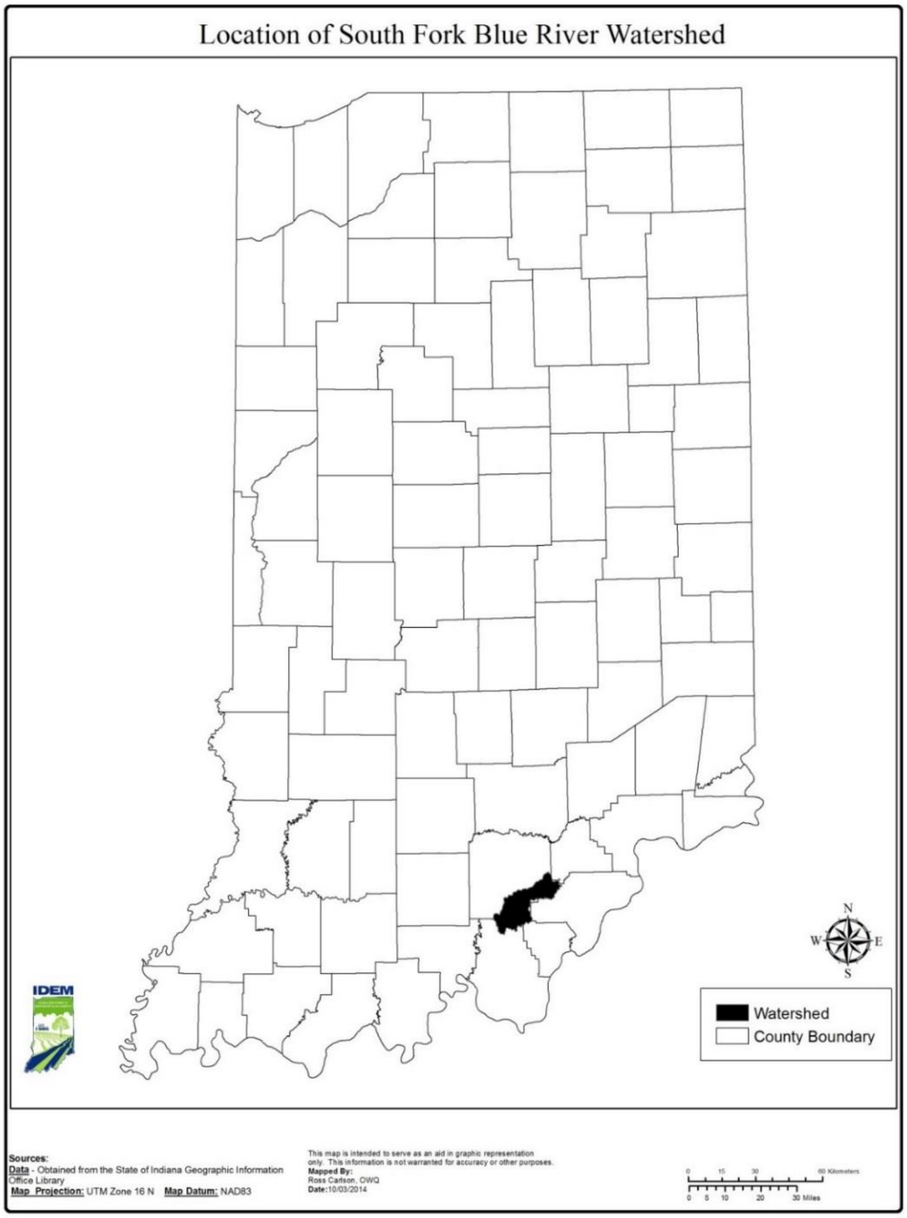

Figure 1: Location of South Fork Blue River Watershed

2.1 Water Quality Standards

Under the CWA, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the CWA's goal of "swimmable/fishable" waters. Water quality standards consist of three different components:

- **Designated uses** reflect how the water can potentially be used by humans and how well it supports a biological community. Examples of designated uses include aquatic life support, drinking water supply, and full body contact recreation. Every waterbody in Indiana has a designated use or uses; however, not all uses apply to all waters. The South Fork Blue River Watershed TMDLs focus on protecting the designated full body contact recreational use of the waterbodies.

The water quality standards in Indiana pertaining to *E. coli* ("the impairments") are described below.

E. coli is an indicator of the possible presence of pathogenic organisms (e.g., enterococcal *E. coli*, viruses, and protozoa) which may cause human illness. The direct monitoring of these pathogens is difficult; therefore, *E. coli* is used as an indicator of potential fecal contamination. *E. coli* is a sub-group of fecal coliform and, the presence of *E. coli* in a water sample indicates recent fecal contamination is likely. Concentrations are typically reported as the count of organisms in 100 milliliters of water (count/100 mL) and may vary at a particular site depending on the baseline *E. coli* level already in the river, inputs from other sources, dilution due to precipitation events, and die-off or multiplication of the organism within the river water and sediments.

The numeric *E. coli* criteria associated with protecting the recreational use are described below.

> *"The criteria in this subsection are to be used to evaluate waters for full body contact recreational uses, to establish wastewater treatment requirements, and to establish effluent limits during the recreational season, which is defined as the months of April through October, inclusive. E. coli bacteria, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period. . . However, a single sample shall be used for making beach notification and closure decisions."* [Source: Indiana Administrative Code Title 327 Water Pollution Control Board. Article 2. Section 6-2(d).]

2.2 Water Quality Targets

Target values are needed for the development of TMDLs because of the need to calculate allowable daily loads. For parameters that have numeric criteria, such as *E. coli*, the target equals the numeric criteria in Section 2.1 Water Quality Standards. For parameters that do not have numeric criteria, target values must be identified from some other source. The target values used to develop the South Fork Blue River Watershed TMDL are presented below.

2.2.1 *E. coli*

The target value used for the South Fork Blue River Watershed TMDL was based on the 235 counts/100 mL single sample maximum component of the water quality standard (i.e., daily loading capacities were calculated by multiplying flows by 235 counts/100 mL). The EPA report, "*An Approach for Using Load Duration Curves in the Development of TMDLs*" (EPA 2007) [1] describes how the monthly geometric mean (125coutns/100mL) is likely to be met when the single sample maximum value (235 counts/100mL) is used to develop the loading capacity. The process calculates the daily maximum bacteria value that is possible to observe and still attain the monthly geometric mean. If the single sample maximum is set as a never-to-be surpassed value then it becomes the maximum value that can be observed, and all other bacteria values would have to be less than the maximum.

2.3 303(d) Listing Information

2.3.1 Understanding Subwatersheds and Assessment Unit IDs (AUIDs)

This section presents information concerning IDEM's segmentation process as it applies to the South Fork Blue River watershed. IDEM identifies the South Fork Blue River Watershed and its tributaries using a watershed numbering system developed by United States Geological Survey (USGS), Natural Resource Conservation Service (NRCS), and the U.S. Water Resources Council referred to as hydrologic unit codes (HUCs). HUCs are a way of identifying watersheds in a nested arrangement from largest (i.e., those with shorter HUCs) to smallest (i.e., those with longer HUCs) [2]. Table 1 and Figure 2 show the 12-digit HUCs located in the South Fork Blue River watershed.

Within each 12-digit HUC subwatershed, IDEM has identified several Assessment Unit IDs (AUIDs), which represent individual stream segments. Through the process of segmenting subwatersheds into AUIDs, IDEM identifies streams reaches and stream networks that are representative for the purposes of assessment. In practice, this process leads to grouping tributary streams into smaller catchment basins of similar hydrology, land use, and other characteristics such that all tributaries within the catchment basin can be expected to have similar potential water quality impacts. Catchment basins, as defined by the aforementioned factors and are typically very small, which significantly reduces the variability in the water quality expected from one stream or stream reach to another. Given this, all tributaries within a catchment basin are assigned a single AUID. Grouping tributary systems into smaller catchment basins also allows for better characterization of the larger watershed and more localized recommendations for implementation activities. Variability within the larger watershed will be accounted for by the differing AUIDs assigned to the different catchment basins.

Table 1 contains the AUIDs in the subwatersheds of the South Fork Blue River watershed and the associated length of each segment. Subsequent sections of the TMDL report organize information by subwatershed (if applicable) and AUID.

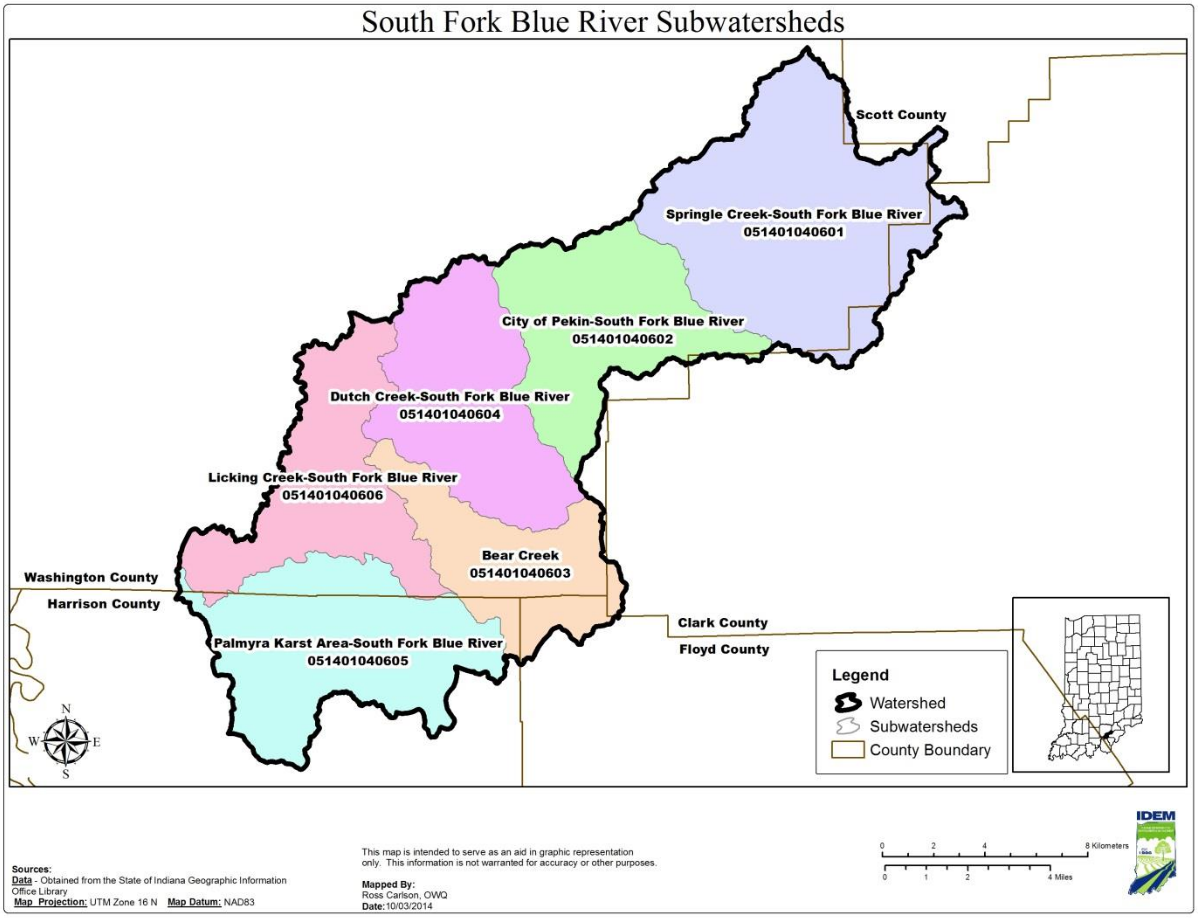

Figure 2: Subwatersheds (12 digit HUCs) in the South Fork Blue River Watershed

2.3.2 Understanding 303(d) Listing Information

There are a number of existing impairments in the South Fork Blue River Watershed from the Draft 2014 303(d) List of Impaired Waters as shown in Figure 3 and Table 1. The listings and causes of impairment have been adjusted as a result of reassessment data collected at 21 sampling locations in the watershed Figure 4 and Table 2. Within the South Fork Blue River Watershed a total of 50 assessment unit IDs (AUIDs) are cited as impaired for *E. coli*, and six AUIDs are cited as impaired for IBC on Indiana's Draft 2018 303(d) list (Figure 5). These impaired segments account for approximately 143 miles. Table 1 presents listing information for the South Fork Blue River Watershed, including a comparison of the updated listings with the Draft 2014 listings and associated causes of impairments addressed by the TMDLs. The reassessment data used in updating the listings for the South Fork Blue River Watershed are available in Appendix B.

Table 1: Assessment Units and 303(d) Listed Impairments in the South Fork Blue River Watershed

Name of Subwatershed	12-digit HUC	AUID 2014	Length (mi)	Draft 2014 Section 303(d) Listed Impairment	AUID 2018	Updated Impairments to be listed on the DRAFT 2018 303(d)
Springle Creek	051401040601	INN0461_01	5.57		INN0461_01	*E. coli*
		INN0461_02	1.23		INN0461_02	*E. coli*, IBC
		INN0461_03	6.41		INN0461_03	*E. coli*
		INN0461_04	3.43	Dissolved Oxygen	INN0461_04	*E. coli*, IBC
		INN0461_P1001	0.71		INN0461_P1001	
		INN0461_T1001	5.78		INN0461_T1001	
		INN0461_T1002	3.93		INN0461_T1002	
		INN0461_T1003	2.24		INN0461_T1003	
		INN0461_T1004	2.67		INN0461_T1004	*E. coli*
		INN0461_T1005	2.13		INN0461_T1005	*E. coli*
		INN0461_T1006	1.95		INN0461_T1006	*E. coli*
		INN0461_T1007	1.18		INN0461_T1007	*E. coli*
		INN0461_T1008	1.10		INN0461_T1008	*E. coli*
		INN0461_T1009	4.40		INN0461_T1009	*E. coli*
		INN0461_T1010	3.31		INN0461_T1010	
		INN0461_T1011	4.39		INN0461_T1011	
		INN0461_T1012	1.14		INN0461_T1012	*E. coli*
		INN0461_T1013	5.42		INN0461_T1013	
		INN0461_T1014	0.98		INN0461_T1014	*E. coli*
		INN0461_T1015	1.19		INN0461_T1015	
		INN0461_T1016	1.75		INN0461_T1016	
		INN0461_T1017	4.29		INN0461_T1017	
		INN0461_T1018	3.32		INN0461_T1018	*E. coli*, IBC
		INN0461_T1019	1.04		INN0461_T1019	
		INN0461_T1020	2.35		INN0461_T1020	
		INN0461_T1021	1.22		INN0461_T1021	
		INN0461_T1022	1.28		INN0461_T1022	
		INN0461_T1023	0.30		INN0461_T1023	
		INN0461_T1023A	0.53		INN0461_T1023A	

Name of Subwatershed	12-digit HUC	AUID 2014	Length (mi)	Draft 2014 Section 303(d) Listed Impairment	AUID 2018	Updated Impairments to be listed on the DRAFT 2018 303(d)
City Of Pekin	051401040602	INN0462_01	2.43		INN0462_01	*E. coli*
		INN0462_02	8.33		INN0462_02	*E. coli*
		INN0462_03	0.39		INN0462_03	
		INN0462_04	0.31		INN0462_04	
		INN0462_05	0.27		INN0462_05	
		INN0462_P1001	0.62		INN0462_P1001	
		INN0462_P1002	0.53		INN0462_P1002	
		INN0462_P1003	0.47		INN0462_P1003	
		INN0462_P1004	0.65		INN0462_P1004	
		INN0462_P1005	0.04		INN0462_P1005	
		INN0462_P1006	0.14		INN0462_P1006	
		INN0462_T1001	3.22		INN0462_T1001	
		INN0462_T1002	3.00		INN0462_T1002	
		INN0462_T1003	3.52		INN0462_T1003	
		INN0462_T1004	3.20		INN0462_T1004	
		INN0462_T1005	0.34		INN0462_T1005	
		INN0462_T1005A	5.05		INN0462_T1005A	
		INN0462_T1006	1.67		INN0462_T1006	
		INN0462_T1007	1.74		INN0462_T1007	*E. coli*
		INN0462_T1008	0.43		INN0462_T1008	*E. coli*
		INN0462_T1009	3.78		INN0462_T1009	*E. coli*
		INN0462_T1010	0.59		INN0462_T1010	*E. coli*
		INN0462_T1011	0.17		INN0462_T1011	*E. coli*
		INN0462_T1011A	0.27		INN0462_T1011A	
		INN0462_T1012	1.58		INN0462_T1012	*E. coli*
		INN0462_T1013	1.65		INN0462_T1013	*E. coli*
		INN0462_T1014	4.41		INN0462_T1014	
		INN0462_T1015	2.70		INN0462_T1015	
		INN0462_T1016	2.39		INN0462_T1016	
		INN0462_T1017	1.15		INN0462_T1017	

Name of Subwatershed	12-digit HUC	AUID 2014	Length (mi)	Draft 2014 Section 303(d) Listed Impairment	AUID 2018	Updated Impairments to be listed on the DRAFT 2018 303(d)
		INN0463_01	4.9	*E. coli*	INN0463_01	*E. coli*
		INN0463_02	3.10	*E. coli*	INN0463_02	*E. coli*
		INN0463_03	4.22	*E. coli*	INN0463_03	*E. coli*
		INN0463_04	3.74	*E. coli*	INN0463_04	*E. coli*
		INN0463_T1001	2.19		INN0463_T1001	*E. coli*
		INN0463_T1002A	0.81		INN0463_T1002A	*E. coli*
		INN0463_T1003	0.63		INN0463_T1003	*E. coli*
Bear Creek	051401040603	INN0463_T1003A	0.69		INN0463_T1003A	
		INN0463_T1004	4.89	*E. coli*	INN0463_T1004	*E. coli*
		INN0463_T1005	3.56	*E. coli*	INN0463_T1005	*E. coli*
		INN0463_T1006	0.62		INN0463_T1006	*E. coli*
		INN0464_01	9.19		INN0464_01	*E. coli*
		INN0464_02	1.73		INN0464_02	*E. coli*
		INN0464_03	1.45		INN0464_03	*E. coli*, IBC
		INN0464_T1001	3.23		INN0464_T1001	
		INN0464_T1002	4.76		INN0464_T1002	
		INN0464_T1003	1.58		INN0464_T1003	*E. coli*
Dutch Creek	051401040604	INN0464_T1004	14.29		INN0464_T1004	IBC
		INN0464_T1005	4.71		INN0464_T1005	*E. coli*
		INN0464_T1006	3.15		INN0464_T1006	*E. coli*, IBC
		INN0464_T1007	2.45		INN0464_T1007	*E. coli*
		INN0464_T1008	2.31		INN0464_T1008	*E. coli*
		INN0464_T1009	1.24		INN0464_T1009	*E. coli*
		INN0464_T1010A	0.71		INN0464_T1010A	
		INN0465_01	4.9		INN0465_01	
Palmyra Karst	051401040605	INN0465_T1001A	2.21		INN0465_T1001A	
		INN0465_T1002A	0.71		INN0465_T1002A	
		INN0465_T1003A	0.36		INN0465_T1003A	
		INN0466_01	2.93		INN0466_01	*E. coli*
		INN0466_02	4.46		INN0466_02	*E. coli*

Name of Subwatershed	12-digit HUC	AUID 2014	Length (mi)	Draft 2014 Section 303(d) Listed Impairment	AUID 2018	Updated Impairments to be listed on the DRAFT 2018 303(d)
Licking Creek	051401040606	INN0466_03	2.95		INN0466_03	*E. coli*
		INN0466_04	1.56	IBC	INN0466_04	*E. coli*
		INN0466_05	0.73		INN0466_05	*E. coli*
		INN0466_06	0.76		INN0466_06	*E. coli*
		INN0466_07	0.18		INN0466_07	*E. coli*
		INN0466_08	1.27		INN0466_08	*E. coli*
		INN0466_P1001	0.31		INN0466_P1001	
		INN0466_T1001A	0.42		INN0466_T1001A	
		INN0466_T1002A	3.36		INN0466_T1002A	
		INN0466_T1002B	0.73		INN0466_T1002B	
		INN0466_T1003	0.37		INN0466_T1003	
		INN0466_T1004	1.73		INN0466_T1004	*E. coli*

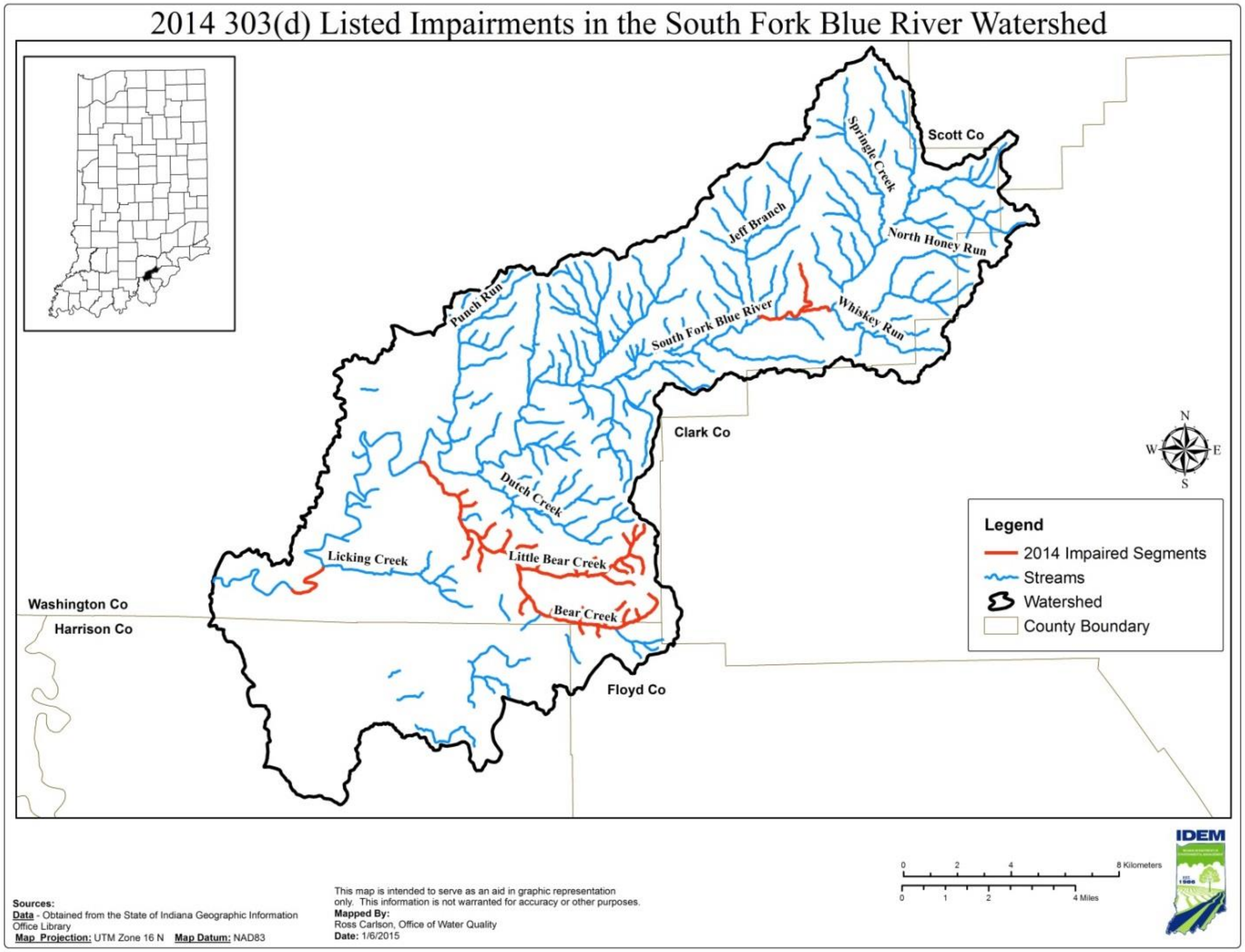

Figure 3: Streams Listed on the Draft 2014 Section 303(d) List in the South Fork Blue River Watershed

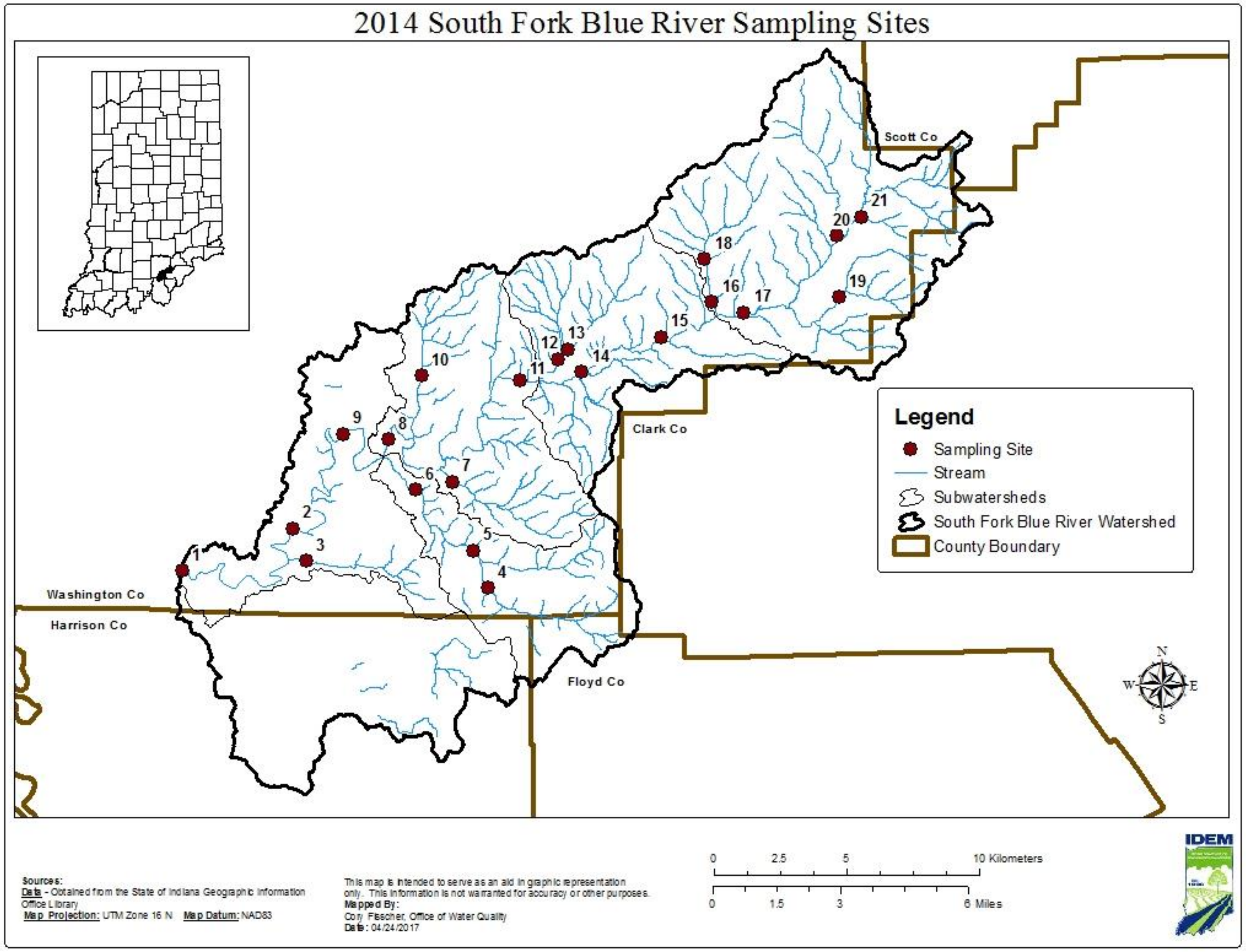

Figure 4: Sampling Locations in the South Fork Blue River Watershed

Table 2: South Fork Blue River Sampling Site Information

Site #	Site ID #	Stream Name	Road Name	AUID
1	OBS130-0002	South Fork Blue River	Fredericksburg Road	INN0466_08
2	OBS-06-0016	South Fork Blue River	Palmyra Rd	INN0466_03
3	OBS-06-0015	Licking Creek	Palmyra Rd	INN0466_T1004
4	OBS-06-0021	Bear Creek	Wetzel Rd	INN0463_02
5	OBS-06-0014	Bear Creek	Martinsburg Fire Rd	INN0463_03
6	OBS-06-0013	Bear Creek	SR 135	INN0463_04
7	OBS-06-0007	Dutch Creek	Dutch Creek Rd	INN0464_T1004
8	OBS-06-0008	South Fork Blue River	SR 135	INN0464_03
9	OBS-06-0020	South Fork Blue River	Big Springs Rd	INN0466_01
10	OBS-06-0009	Punch Run	Shorts Corner Rd	INN0464_T1006
11	OBS-06-0004	South Fork Blue River	Martinsburg Rd	INN0464_01
12	OBS-06-0006	Tributary of South Fork Blue River	Shorts Corner Rd	INN0462_T1013
13	OBS-06-0012	Tributary of South Fork Blue River	Mahuron Rd	INN0462_T1009
14	OBS-06-0018	South Fork Blue River	Main St	INN0462_02
15	OBS-06-0022	South Fork Blue River	Lockenour Rd	INN0462_02
16	OBS-06-0003	Jeff Branch	E Blue River Rd	INN0461_T1080
17	OBS-06-0002	South Fork Blue River	Bowers Knob Rd	INNO461_04
18	OBS-06-0019	Jeff Branch	Bethel Rd	INN0461_T1008
19	OBS-06-0011	Honey Run	North Honey Run Rd	INN0461_T1012
20	OBS-06-0005	Springle Creek	Blue River Rd	INN0461_T1006
21	OBS-06-0010	Poplar Branch	Casey Hallow Rd	INN0461_02

Understanding Table 2: South Fork Blue River Sampling Site InformationTable 2:

- *Column 1: Site #*. Lists the site number that corresponds to the site location in Figure 4
- *Column 2: Site ID #* Provides the IDEM Assessment Information Management System (AIMS) database assigned number
- *Column 3: Stream Name*. Identifies the Stream Name that the site is located on
- *Column 3: Road Name.* Identifies the Road Name that the site is located on
- *Column 4: AUID.* Identifies the AUID given to waterbodies within the 12-digit HUC sub watershed for purposes of the Draft 2018 Section 303(d) listing assessment process

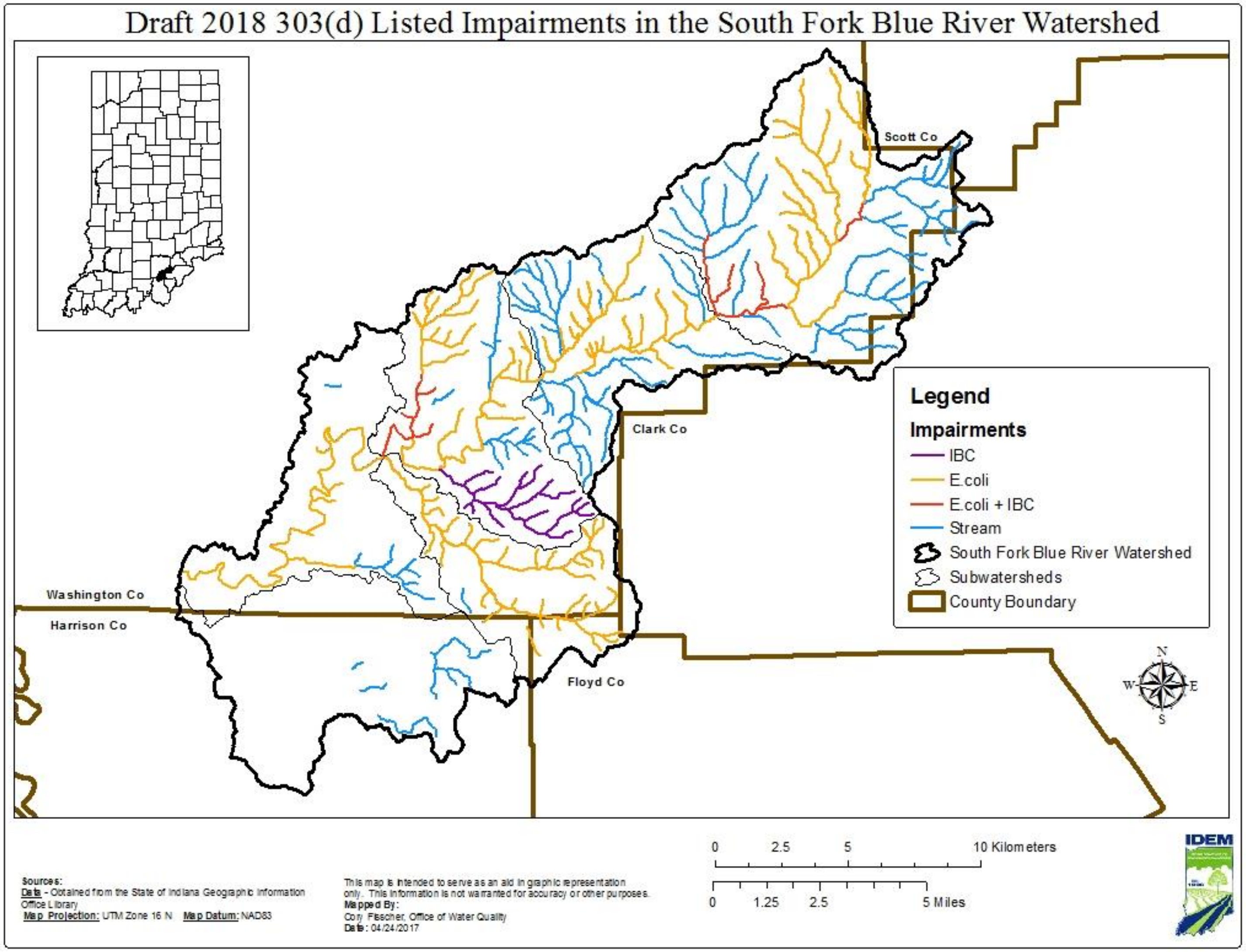

Figure 5: Streams Listed on the Draft 2018 Section 303(d) List in the South Fork Blue River Watershed

2.4 Water Quality Information

This section of the TMDL report contains a brief characterization of the South Fork Blue River Watershed water quality information that was collected in development of this TMDL. Understanding the natural and human factors affecting the watershed will assist in selecting and tailoring appropriate and feasible implementation activities to achieve water quality standards. Below is an inventory of the available chemistry data for the South Fork Blue River watershed related to *E. coli*.

2.4.2 Water Chemistry Data

Table 3 summarizes the water chemistry data within the South Fork Blue River Watershed by displaying the maximum concentrations at all impaired stations along with the reduction needed to meet the TMDL. Data sampled in 2015 by IDEM were used for the TMDL analysis.

The percent reductions were calculated as follows:

$$\%\ \text{Reduction} = \frac{(\text{Observed Concentration} - \text{Target Value or WQS})}{\text{Observed Concentration}}$$

Appendix A shows the individual sample results and summaries of all the water quality data for all 21 monitoring stations.

2.4.3 *E. coli* Data

For pathogens, the 143 of the 240 AUIDs in the South Fork Blue River were assessed. Table 3 below provides a summary of pathogen data for all of the subwatersheds in the South Fork Blue River.

Table 3: Summary of Pathogen Data in South Fork Blue River by Subwatershed

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
Springle Creek	OBS-06-0010 (T21)	INN0461_02	4/7/2015-10/6/2015	10	90%	50%	457.16	5,794	73%
	OBS-06-0002 (T17)	INN0461_04	11/12/2014-10/6/2015	15	67%	53%	403.37	5,475	69%
	OBS-06-0005 (T20)	INN0461_T106	4/7/2015-9/14/2015	9	22%	33%	627.37	4,611	80%
	OBS-06-0011 (T19)	INN0461_T1012	4/7/2015-9/14/2015	10	90%	70%	277.13	>2419.6	55%
	OBS-06-003 (T16)	INN0461_T1018	4/7/2015-9/14/2015	10	70%	70%	398.75	1,986.3	69%
	OBS-06-0010 (T18)	INN0461_T1018	4/7/2015-9/14/2015	9	67%	44%	42.7	>2419.6	NA
City Of Pekin	OBS-06-0022 (T15)	INN0462_02	11/12/2014 -10/6/2015	15	73%	47%	240.8	7,701	48%
	OBS-06-0018 (T14)	INN0462_02	4/7/2015-10/6/2015	10	70%	50%	255.4	8,664	51%
	OBS-06-0012 (T13)	INN0462_T1009	4/7/2015-10/6/2015	10	90%	80%	467.69	3,448	73%
	OBS-06-0006 (T12)	INN0462_T1013	4/6/2015 – 10/5/2015	10	70%	50%	171.76	1,986.3	27%
Bear Creek	OBS-06-0021 (T04)	INN0463_02	4/6/2015 – 10/5/2015	10	90%	80%	350.09	816.4	64%
	OBS-06-0014 (T05)	INN0463_03	4/6/2015 – 10/5/2015	10	90%	90%	901.78	2,100.3	86%
	OBS-06-0013 (T06)	INN0463_04	11/12/2014 -10/5/2015	15	87%	73%	678.22	1,046.2	82%
Dutch Creek	OBS-06-0004 (T11)	INN0464_01	11/12/2014 -10/5/2015	15	93%	73%	654.77	1203.3	81%
	OBS-06-0008 (T08)	INN0464_03	11/12/2014 -10/5/2015	15	60%	47%	162.71	2,040.7	23%
	OBS-06-0007 (T07)	INN0464_T1004	4/6/2015 – 10/5/2015	10	40%	20%	42.72	410.6	NA
	OBS-06-0009 (T10)	INN0464_T1006	4/6/2015 – 9/1/2015	9	89%	78%	392.18	1,912.6	68%
Palmyra Karst	NA	NA	NA	NA	NA	NA	NA	NA	NA
Licking Creek	OBS-06-0020 (T09)	INN0466_01	4/6/2015 – 10/5/2015	10	80%	40%	173.2	1,119.9	28%
	OBS-06-0016 (T02)	INN0466_03	4/6/2015 – 10/5/2015	10	90%	90%	1,089.14	4,611	89%
	OBS-06-0002 (T01)	INN0466_08	11/12/2014 -10/5/2015	15	87%	80%	330.5	1,059.4	62%
	OBS-06-0015 (T03)	INN0466_T1004	4/6/2015 – 10/5/2015	10	100%	70%	291.46	866.4	57%

3.0 DESCRIPTION OF THE WATERSHED AND SOURCE ASSESSMENT

This section of the TMDL report contains a brief characterization of the South Fork Blue River Watershed to provide a better understanding of the historic and current conditions of the watershed that affect water quality and contribute to the existing impairments. Understanding the natural and human factors affecting the watershed will assist in selecting and tailoring appropriate and feasible implementation activities to achieve water quality standards.

As discussed in Section 2.0, the South Fork Blue River watershed contains six 12-digit HUC subwatersheds. Examining subwatersheds enables a closer examination of key factors that affect water quality. The subwatersheds include (Figure 2):

- Springle Creek (051401040601) 32 sq miles
- City of Pekin (051401040602) 19 sq miles
- Bear Creek (051401040603) 14 sq miles
- Dutch Creek (051401040604) 19 sq miles
- Palmyra Karst (051401040605) 23 sq miles
- Licking Creek (051401040606) 18 sq miles

This section summarizes the available information on significant point and nonpoint sources of *E. coli* in, six subwatersheds of the South Fork Blue River watershed.

The term "point source" refers to any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel or conduit, by which pollutants are transported to a waterbody. It also includes vessels or other floating craft from which pollutants are or may be discharged. By law, the term "point source" also includes: concentrated animal feeding operations (CAFO), which are places where animals are confined and fed; and illicitly connected "straight pipe" discharges of household waste. Permitted point sources are regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Nonpoint sources include all other categories not classified as point sources. In urban areas, nonpoint sources can include leaking or faulty septic systems, runoff from lawn fertilizer applications, pet waste and other sources. In rural areas, nonpoint sources can include runoff from cropland, pastures and animal feeding operations and inputs from leaking, failing or straight-piped septic systems, and wildlife.

3.1 Land Use

Land use patterns provide important clues to the potential sources of *E. coli* impairments in the South Fork Blue River Watershed. Land use information for the South Fork Blue River watershed is available from the Multi-Resolution Land Characteristics Consortium (MRLC) [2]. These data categorize the land use for each 30 meters by 30 meters parcel of land in the watershed, based on satellite imagery from 2011. Figure 6 displays the spatial distribution of the land uses and the data are summarized in Table 4 and Table 5.

Land use in the South Fork Blue River watershed is primarily forested, comprising 45 percent of the watershed. Approximately 29 percent of the land is hay and/or pasture and 20 percent is agricultural. Pasture/hay land use could indicate the presence of animal feedlots which can be significant sources of *E. coli* if animals have direct access to the stream corridor. Corn and soybean crops are not typically associated with high *E. coli* loads, unless they have been fertilized with manure. The remaining land categories represent approximately 6 percent of the total land area.

The South Fork Blue River watershed has a diverse network of streams. Tributaries include Licking Creek, Bear Creek, Dutch Creek, Punch Run, Jeff Branch, Honey Run, and Springle Creek, among others. The headwaters of the watershed quickly drain the wooded ridges that surround the watershed. This is most pronounced in the areas of Scott and Clark County that fall within the watershed, but is also true of the eastern portion of Washington County. These streams settle in the South Fork Blue River and meander southwest in a valley the river has created. West of Palmyra, agriculture becomes the more predominant land use, yet the stream retains its sinuosity. Riparian zones reduce in size but are still present along the majority of the channel. The Southern portion of the watershed is unique in its Karst dominated topography. With many sinkholes and seeps, much of the water drains to the ground water, leaving little to no overland flow in the area. Many threatened and endangered species call this watershed home. Most of them can be tied to the cave systems in the area, while others, like the Eastern Hellbender, living in the Blue River, are dependent on the upon the health of the aquatic system. Of the four threatened or endangered fish found in the larger Blue River system none were identified during IDEM sampling. Additional information on state endangered, threatened and rare species can be found on the DNR website [2].

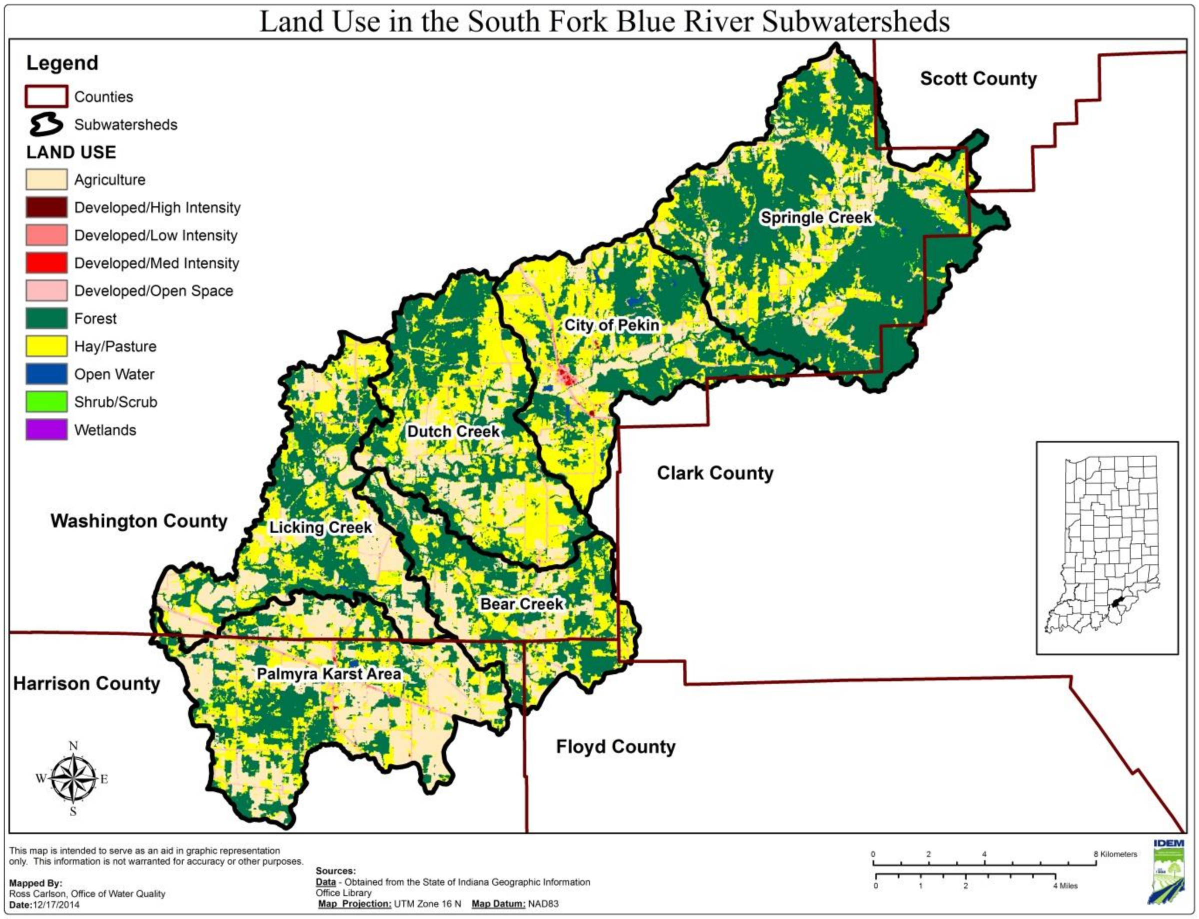

Figure 6: Land Use in the South Fork Blue River Watershed

Table 4: Land Use of the South Fork Blue River Watershed

Land Use	Watershed		
	Area		Percent
	Acres	Square Miles	
Agricultural Lands	15,979.52	24.968	19.79
Developed Land	3,879.68	6.062	4.80
Forested Land	36,719.36	57.374	45.47
Pasture/Hay	23,242.88	36.317	28.78
Grasslands and Shrubs	660.48	1.032	0.822
Wetlands	1.92	0.003	0.01
Open Water	264.32	0.413	0.33
TOTAL	**80,748.16**	**126.169**	**100**

Understanding Table 4: The predominant land use types in the South Fork Blue River watershed can indicate potential sources of *E. coli* loadings. Different types of land uses are characterized by different types of hydrology. For example, developed lands are characterized by impervious surfaces that increase the potential of storm water events during high flow periods delivering loads to downstream streams and rivers. Forested land and wetlands allow water to infiltrate slowly, thus reducing the risks of polluted water running off into waterbodies. In addition to differences in hydrology, land use types are associated with different types of activities that could contribute water quality violations to the watershed. Understanding types of land uses will help to identify the type of implementation approaches that watershed stakeholders can use to achieve necessary load reductions.

Table 5: Land Use in the South Fork Blue River Subwatersheds

Subwatershed	Area	Land Use							Total
		Agriculture	Developed	Forest	Hay/ Pasture	Shrub/ Scrub	Open Water	Wetlands	
Springle Creek (051401040601)	Acres	2,029	828	13,553	4,306	174	59	0	20,949
	Sq. Mi.	3.17	1.29	21.17	6.72	0.27	0.09	0	32.71
	Percent	9.7	3.95	64.78	20.56	0.83	0.28	0	100
City of Pekin (051401040602)	Acres	1,420	792	4,819	4,841	93	130	1	12,096
	Sq. Mi.	2.21	1.23	7.52	7.56	0.14	0.20	0	18.86
	Percent	11.73	6.52	39.87	40.08	0.74	1.06	0	100
Bear Creek (051401040603)	Acres	1,759	403	3,974	2,712	75	9	0	8,932
	Sq. Mi.	2.75	0.63	6.21	4.24	0.12	0.01	0	13.96
	Percent	19.7	4.51	44.48	30.37	0.86	0.08	0	100
Dutch Creek (051401040604)	Acres	2,171	482	5,203	4,449	100	5	0	12,410
	Sq. Mi.	3.39	0.75	8.12	6.95	0.15	0.01	0	19.37
	Percent	17.5	3.87	41.92	35.88	0.77	0.06	0	100
Palmyra Karst (051401040605)	Acres	5,524	882	4,438	3,728	108	43	0	14,723
	Sq. Mi.	8.63	1.34	6.93	5.83	0.17	0.07	0	22.97
	Percent	37.68	5.85	30.26	25.45	0.74	0.3	0	100
Licking Creek (051401040606)	Acres	3,081	480	4,567	3,214	105	16	0	11,463
	Sq. Mi.	4.81	0.75	7.14	5.02	0.16	0.03	0	17.91
	Percent	26.86	4.19	39.87	28.03	0.89	0.16	0	100

3.1.1 Cropland

Croplands can be a source of E. coli, accumulation of E. *coli* on cropland occurs from decomposition of manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Use of manure for nitrogen supplementation often results in excessive *E. coli* loads relative to crop requirements (USEPA, 2003).

Watershed specific data are not available for field specific crops. However, USDA CropScape and Cropland Data Layers [5]available from the National Agricultural Statistic Service (NASS) were downloaded to view agricultural land use in each subwatershed. The purpose of the Cropland Data Layer Program is to use satellite imagery to (1) provide planted acreage estimates to the Agricultural Statistics Board for the state's major commodities and (2) produce digital, crop-specific, categorized geo-referenced output products. [5] Classification accuracy is generally 85% to 95% correct for the major crop-specific land cover categories. The 2012 NASS statistics were used in the analysis, as shown in Table 6 and Figure 7.

Table 6: Major Cash Crop Acreage in the South Fork Blue River Watershed

Subwatershed	Crop	Total Acreage	% of Subwatershed Cash Crop Acreage
Springle Creek (051401040601)	Corn	1,411	34%
	Soybean	2,733	66%
	Winter Wheat	0	0%
	Total	4,144	100
City of Pekin (051401040602)	Corn	712	50%
	Soybean	700	49%
	Winter Wheat	1	1%
	Total	1,412	100%
Dutch Creek (051401040603)	Corn	1139	53%
	Soybean	995	46%
	Winter Wheat	1	1%
	Total	2,135	100%
Bear Creek (051401040604)	Corn	886	55%
	Soybean	737	45%
	Winter Wheat	0	0%
	Total	1,623	100%
Palmra Karst Area (051401040605)	Corn	2,959	54%
	Soybean	2,512	45%
	Winter Wheat	2	1%
	Total	5,473	100%
Licking Creek (051401040606)	Corn	1,847	60%
	Soybean	1,206	40%
	Winter Wheat	0	0%
	Total	3,053	100%

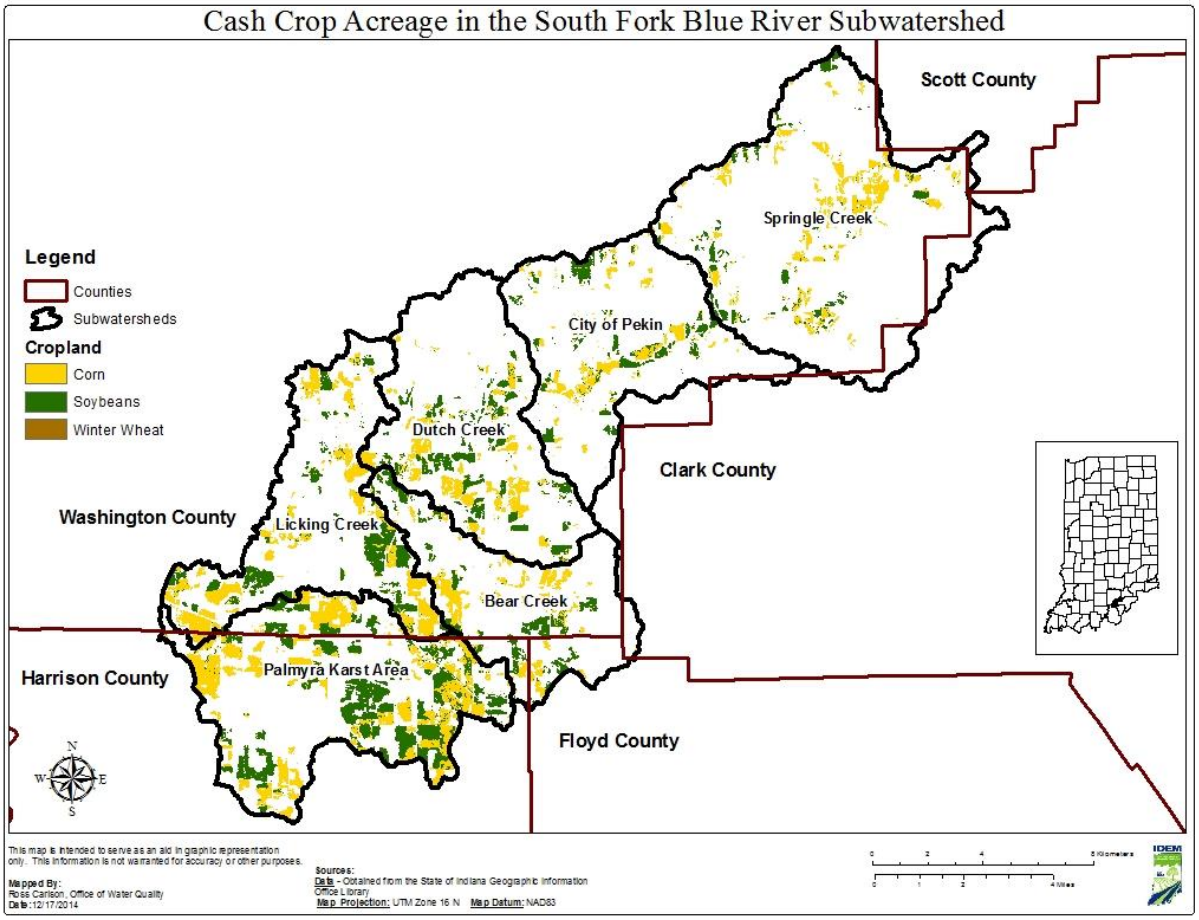

Figure 7: Cash Crop Acreage in the South Fork Blue River Subwatersheds

3.1.2 Pastureland

Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential sources of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service [6]were downloaded and area was weighted to estimate animal population in the subwatersheds. The area of the county within the subwatersheds is divided by the area of the entire county and multiplied by the total number of animals in the county based on the 2012 NASS survey. This is done for each county in the subwatersheds and summed to get an area weighted estimate of animals within the subwatersheds. There are an estimated 5,787 animal units in the South Fork Blue River watershed and the animal unit density is 46 animal units per square mile as shown in Table 8.

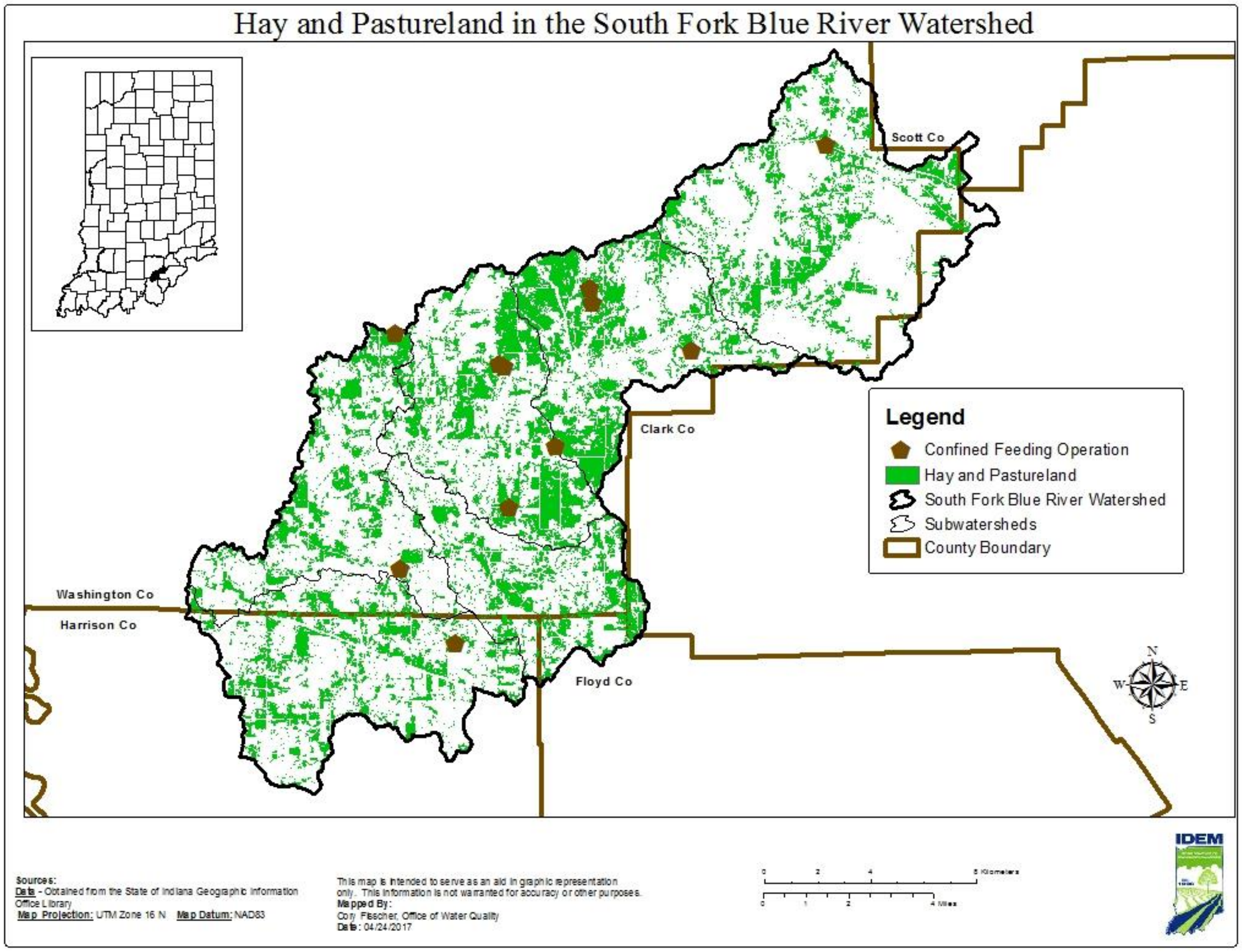

Figure 8: Hay and Pastureland and Confined Feeding Operations in the South Fork Blue River Watershed

3.1.3 Confined Feeding Operations (CF0s) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified as CFOs by IDEM are considered nonpoint sources by USEPA. Indiana’s CFOs have state-issued permits and are therefore categorized as

nonpoint sources for the purposes of this TMDL. CFO permits are “no discharge” permits. Therefore it is prohibited for these facilities to discharge to any water of the State.
The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations “not cause or contribute to an impairment of surface waters of the state”. IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs can also be a potential source of *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure over application or improper application can adversely impact soil productivity.

There are eleven CFOs in the South Fork Blue River as shown in Table 7 and Figure 8.

Table 7: CFOs in the South Fork Blue River Watershed

Subwatershed	CFO Permit ID	Operation Name	County	Animal Type and Permitted number
Springle Creek	6676	Tim and Jonica Branaman	Washington	Broilers: 97,500
City of Pekin	840	Wright Brothers Farm	Washington	Broilers: 180,000
	4999	William Powers	Washington	Broilers: 105,100
	6260	Souder Farm	Washington	Broilers: 99,300
	60890	Jerald Green	Washington	Broilers: 198,000
Bear Creek	NA	NA	NA	NA
Dutch Creek	193	David Pickerill	Washington	Broilers: 115,000
	727	Gary M Temple	Washington	Broilers: 107,400
	6554	Jeffrey Pickerill	Washington	Broilers: 132,400
Palmyra Karst Area	4165	Glenn Beach	Harrison	Nursery Pig: 500 Finishers: 1,250 Sows: 142
Licking Creek	**2833**	Cory Beach	Washington	Broilers: 192,600
	3488	Purlee and Purlee Farms	Washington	Broilers: 280,000

Table 8: Animal Unit Density in the South Fork Blue River Subwatersheds

	Hogs and Pigs	**Cattle and Calves**	**Sheep and Goats**	**Horses and Ponies**	**Poultry**
Number of Animals in One Animal Unit	2.5	1	10	0.5	250
Total Number of Head in County					
Washington	10,540	15,729	1,500	1,233	146,238
Harrison	6,703	19,464	1,183	1,327	2,316
Scott	39	1713	738	654	453
Clark	280	6,228	805	669	No data
Floyd	54	3676	424	436	429

Total Number of Animal Units in Subwatersheds

Watershed	Subwatershed	Hogs and Pigs	Cattle and Calves	Sheep and Goats	Horses and Ponies	Poultry	**Total**	**Animal Unit Density (animal units/mi²)**
South Fork Blue River	Springle Creek	239	942	9	154	250	1594	50
	City Of Pekin	153	572	5	90	21	841	26
	Bear Creek	158	590	6	93	22	869	45
	Dutch Creek	62	369	4	65	8	507	36
	Palmyra Karst	136	901	6	125	4	1,172	50
	Licking Creek	146	547	5	86	20	804	45

3.3 Topography and Geology

Topographic and geologic features of a watershed play a role in defining a watershed's drainage pattern. Information concerning the topography and geology within the South Fork Blue River Watershed is available from the Indiana Geologic Survey (IGS). The South Fork Blue River Watershed originates in Washington County and travels southwest, eventually discharging into the Blue River. The South Fork Blue River Watershed is located in the Norman Upland and Mitchell Plateau physiographic regions which is characterized by rolling clay-covered upland of low relief and large areas of karst, entrenched by major valleys, as well as having bedrock hills of high relief (https://igs.indiana.edu/Surficial/Landscapes.cfm). Figure 9 shows the topography of the South Fork Blue River watershed. National Elevation Data (NED) is available from the USGS National Map seamless server (https://viewer.nationalmap.gov/launch/).

The entire bedrock surface of Indiana consists of sedimentary rocks. The major kinds of sedimentary rock in Indiana include limestone, dolomite, shale, sandstone, and siltstone. The northern two-thirds of Indiana are composed of glacial deposits containing groundwater. These glacial aquifers exist where sand and gravel bodies are present within clay-rich glacial till (sediment deposited by ice) or in alluvial, coastal, and glacial outwash deposits. Groundwater availability is much different in the southern unglaciated part of Indiana. There are few unconsolidated deposits above the bedrock surface, and the voids in bedrock (other than karst dissolution features) are seldom sufficiently interconnected to yield useful amounts of groundwater. Reservoirs, such as Monroe Lake and Patoka Lake, are used for water supply in lieu of water wells in southern Indiana (http://igs.indiana.edu/Groundwater/)

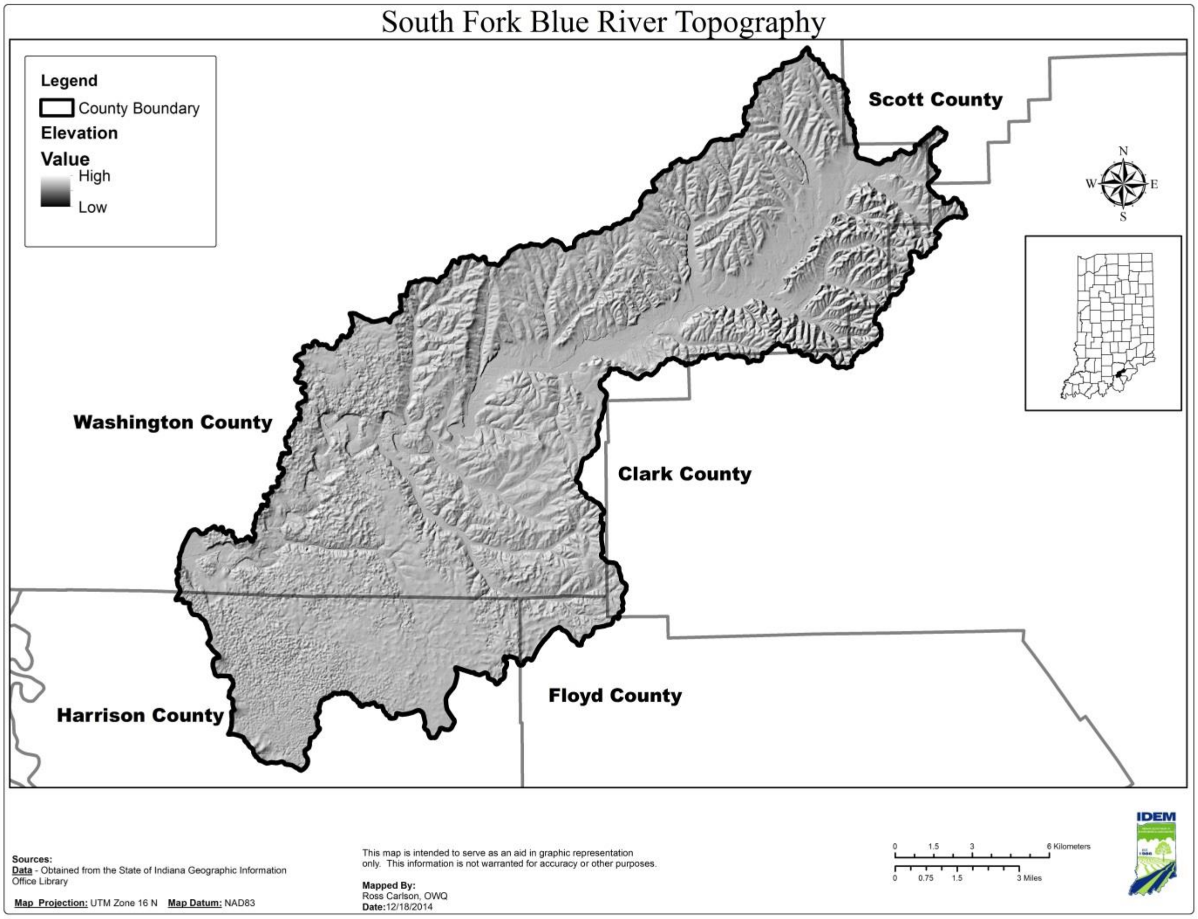

Figure 9: Topography of the South Fork Blue River Watershed

3.3.1 Karst Geology

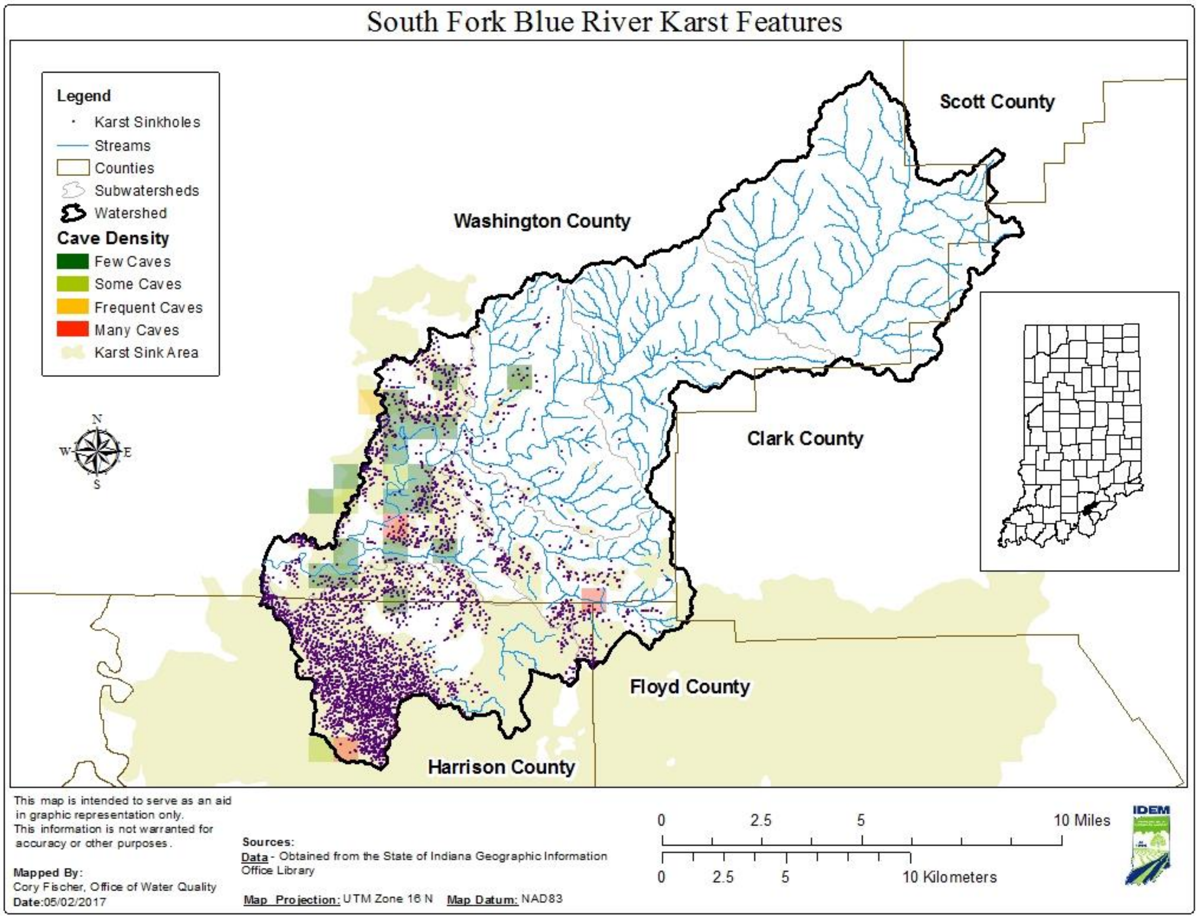

Figure 10. Karst Features in the South Fork Blue River Watershed

Karst regions are characterized by the presence of limestone or other soluble rocks, where drainage has been largely diverted into subsurface routes. The topography of such areas is dominated by sinkholes, sinking streams, large springs, and caves.

Many subsurface drainage networks in this area are fed by surface streams that sink into caves or swallow holes. Activities that impact the surface water quality can thus be expected to affect ground water as well. Due to the nature of conduit flow, impacts are likely to be ephemeral, and determination of exact directions of transport or affected conduits may be problematic in the absence of detailed dye-tracing studies. While the State of Indiana has performed dye-tracing studies in southern Indiana none have been performed within the South Fork Blue River. (Atlas of hydrogeologic terrains and settings of Indiana 1995)

The Indiana Karst Conservancy (IKC) is a 501(c)(3) non-profit organization dedicated to the preservation and conservation of Indiana's unique karst features. Unfortunately, many karst features are subject to incompatible or damaging uses. Most are on private land, occasionally with owners apathetic to their preservation or unaware of their significance. The Indiana Karst Conservancy provides protection and awareness of karst features and the unique habitat they provide. For more information regarding the IKC you can visit their website at http://www.ikc.caves.org/.

3.4 Soils

There are different soil characteristics that can affect the health of the watershed. These characteristics include soil drainage, septic tank suitability, soil saturation, and soil erodibility.

3.4.1 Soil Drainage

The hydrologic soil group classification is a means for categorizing soils by similar infiltration and runoff characteristics during periods of prolonged wetting. The NRCS has defined four hydrologic groups for soils, described in Table 9 (NRCS, 2001). Data for the South Fork Blue River watershed were obtained from the Soil Survey Geographic (SSURGO) database. Downloaded data were summarized based on the major hydrologic group in the surface layers of the map unit and are displayed in Figure 11.

The majority of the watershed is covered by category B soils (61%) followed by category C soils (36%), and category D soils (.0001%).

Table 9: Hydrologic Soil Groups

Hydrologic Soils Group	Description
A	Soils with high infiltrations rates. Usually deep, well drained sands or gravels. Little runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff.

Understanding Table 9: Typically, clay soils that are poorly drained have lower infiltration rates, while well-drained sandy soils have the greatest infiltration rates.

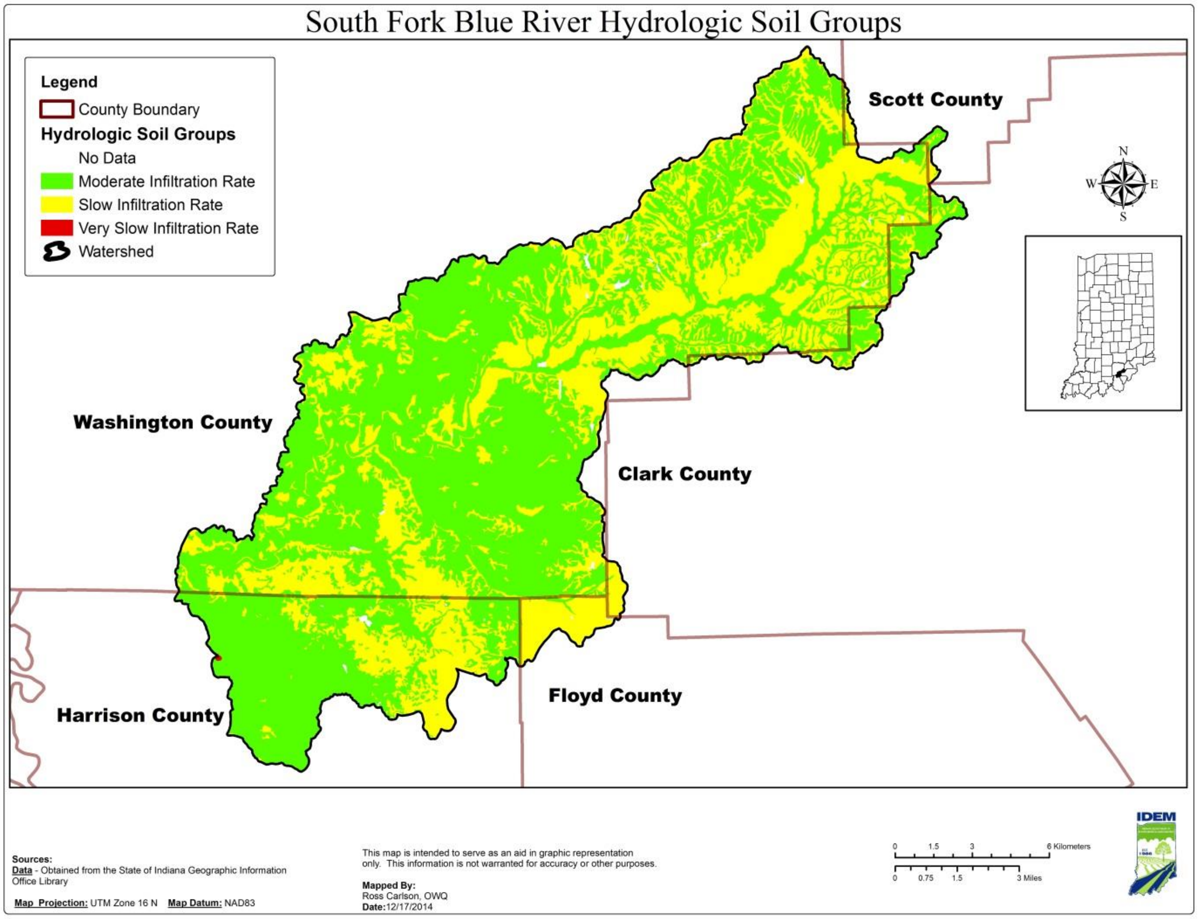

Figure 11: Hydrological Soil Groups in the South Fork Blue River Watershed

3.4.2 Septic Tank Absorption Field Suitability

Septic systems require soil characteristics and geology that allow gradual seepage of wastewater into the surrounding soils. Seasonal high water tables, shallow compact till and coarse soils present limitations for septic systems. While system design can often overcome these limitations (i.e., perimeter drains, mound systems or pressure distribution), sometimes the soil characteristics prove to be unsuitable for any type of traditional septic system.

Heavy clay soils require larger (and therefore more expensive) absorption fields; while sandier, well-drained soils are often suitable for smaller, more affordable gravity-flow trench systems.

The septic system is considered failing when the system exhibits one or more of the following:

1. The system refuses to accept sewage at the rate of design application thereby interfering with the normal use of plumbing fixtures.

2. Effluent discharge exceeds the absorptive capacity of the soil, resulting in ponding, seepage, or other discharge of the effluent to the ground surface or to surface waters.

3. Effluent is discharged from the system causing contamination of a potable water supply, ground water, or surface water.

Figure 12 shows ratings that indicate the extent to which the soils are suitable for septic systems within the South Fork Blue River Watershed. Only that part of the soil between depths of 24 and 60 inches is evaluated for septic system suitability. The ratings are based on the soil properties that affect absorption of the effluent, construction, maintenance of the system, and public health.

Soils labeled "very limited" indicate that the soil has at least one feature that is unfavorable for septic systems. Approximately 71 percent of the South Fork Blue River watershed is considered "very limited" in terms of soil suitability for septic systems. These limitations generally cannot be overcome without major soil reclamation or expensive installation designs. Approximately less than one percent of the soils within the South Fork Blue River watershed are "not rated," meaning these soils have not been assigned a rating class because it is not industry standard to install a septic system in these geographic locations. Approximately 28 percent of the soils in the South Fork Blue River watershed are designated "somewhat limited," meaning that the soil type is suitable for septic systems.

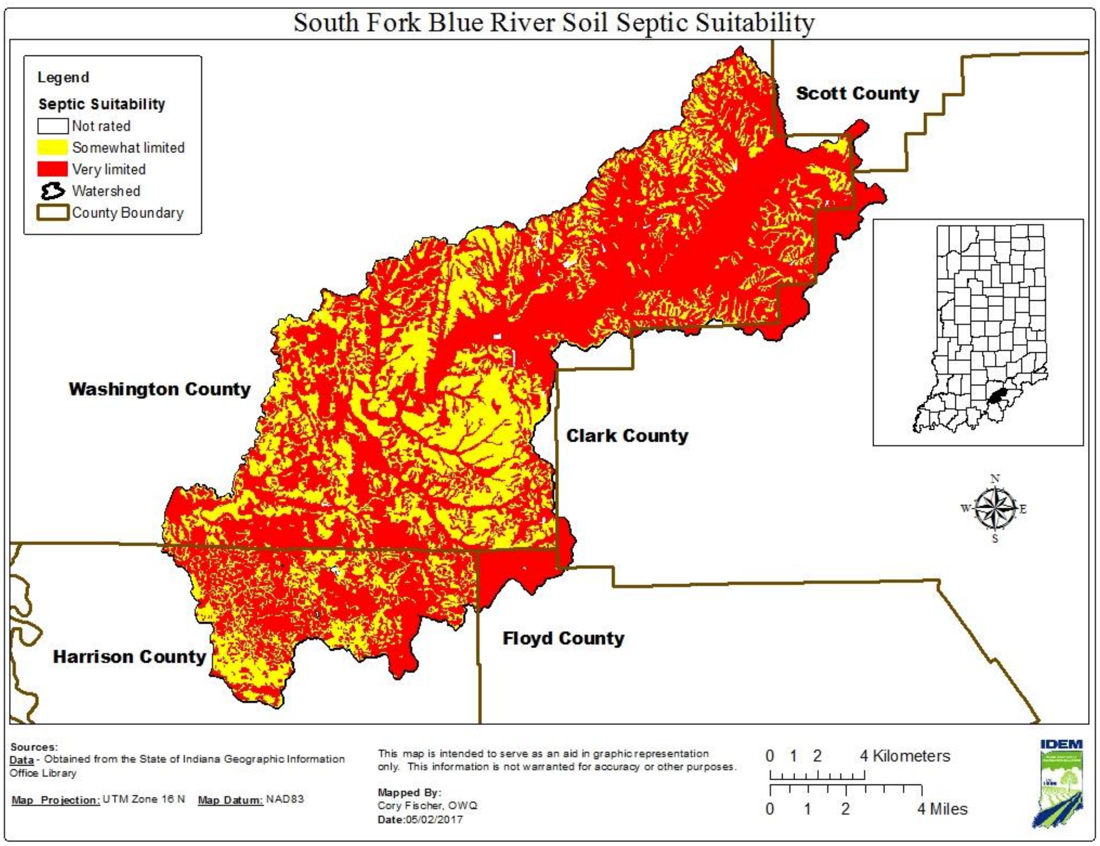

Figure 12: Suitability of Soils for Septic Systems in the South Fork Blue River Watershed

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeological (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli*, nitrate + nitrite, and total phosphorus (Horsely and Witten, 1992). Septic systems contain all of the water discharged from homes and businesses and can be significant sources of pathogens.

The Indiana State Department of Health (ISDH) regulates (410 IAC 6-8.3) through the local health department's residential onsite sewage disposal program. Onsite sewage disposal systems (i.e., septic systems) are those, which do not result in an off-lot discharge of treated effluent, typically consisting of a septic tank to settle out and digest sewage solids, followed by a system of perforated piping to distribute the treated wastewater for absorption into the soil. More than 800,000 onsite sewage disposal systems are currently used in Indiana. Local health departments issue more than 15,000 permits per year for new systems, and about 6,000 permits for repairs.

410 IAC 6-8.3-52 General sewage disposal requirements

Sec. 52. (a) No person shall throw, run, drain, seep, or otherwise dispose into any of the surface waters or ground waters of this state, or cause, permit, or suffer to be thrown, run, drained, allowed to seep, or otherwise disposed into such waters, any organic or inorganic matter from a dwelling or residential onsite sewage system that would cause or contribute to a health hazard or water pollution. (b) The: (1) design; (2) construction; (3) installation; (4) location; (5) maintenance; and (6) operation; of residential onsite sewage systems shall comply with the provisions of this rule.

410 IAC 6-8.3-55 Violations; permit denial and revocation

Sec. 55. (a) Should a residential onsite sewage system fail, the failure shall be corrected by the owner within the time limit set by the health officer. (b) If any component of a residential onsite sewage system is found to be: (1) defective; (2) malfunctioning; or (3) in need of service; the health officer may require the repair, replacement, or service of that component. The repair, replacement, or service shall be conducted within the time limit set by the health officer. (c) Any person found to be violating this rule may be served by the health officer with a written order stating the nature of the violation and providing a time limit for satisfactory correction thereof.

A comprehensive database of septic systems within the South Fork Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural household density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural households in the South Fork Blue River subwatersheds are shown in Table 10, along with a calculated density (total rural households divided by total area). The rural household density can be used to compare the different subwatersheds within the South Fork Blue River watershed.

It should also be noted that hydrologic soil group A and B soils have good infiltration rates and have less risk for failing septic systems due to this factor. Group C and D soils have slow infiltration rates with finer textures and slow water movement. Table 10 illustrates the hydrologic soil groups for the South Fork Blue River subwatersheds.

Table 10: Hydrologic Soil Groups in the South Fork Blue River Subwatersheds

Subwatershed	Hydrologic Soil Group			
	A	B	C	D
Springle Creek	0%	48.61%	51.37%	0.02%
City of Pekin	0%	54.94%	44.95%	0.02%
Dutch Creek	0%	84.67%	15.32%	0.01%
Bear Creek	0%	69.62%	29.55%	0.83%
Palmyra Karst Area	0%	66.4%	33.59%	0.01%
Licking Creek	0%	62.51%	35.81%	1.68%

Table 11: Rural Household Density in the South Fork Blue River Subwatersheds

Subwatershed	County	Area of County in Subwatershed (mi^2)	County Households in Subwatershed	Urban Households	Rural Households	Rural Household Density (Houses/mi^2)
Springle Creek	Washington	29.57	954	0	954	**37**
	Scott	0.48	48	0	48	
	Clark	2.67	193	0	193	
	Total	**32.72**	**1195**	**0**	**1195**	
City of Pekin	Washington	18.75	1490	627	863	**51**
	Clark	0.14	104	0	104	
	Total	**18.89**	**1594**	**627**	**967**	
Dutch Creek	Washington	19.39	874	0	874	**46**
	Total	**19.39**	**874**	**0**	**874**	
Bear Creek	Washington	10.13	559	0	559	**82**
	Clark	0.51	174	0	174	
	Floyd	2.21	341	0	341	
	Harrison	1.11	72	0	72	
	Total	**13.96**	**1146**	**0**	**1146**	
Palmyra Karst	Washington	3.18	161	11	150	**53**
	Harrison	20.05	1400	336	1064	
	Total	**23.23**	**1561**	**347**	**1214**	
Licking Creek	Washington	17.74	822	13	809	**50**
	Harrison	0.17	84	0	84	
	Total	**17.91**	**906**	**13**	**893**	

3.4.3 Soil Saturation and Wetlands

Soils that remain saturated or inundated with water for a sufficient length of time become hydric through a series of chemical, physical, and biological processes. Once a soil takes on hydric characteristics, it retains those characteristics even after the soil is drained. Hydric soils have been identified in the South Fork Blue River Watershed and are important in consideration of wetland restoration activities.

Approximately 680 acres or 0.7 percent of the South Fork Blue River Watershed area contains soils that are considered hydric, as shown in Table 12. However, a large majority of these soils have been drained for either agricultural production or urban development and would no longer support a wetland. The location of remaining hydric soils, as shown in Figure 13, can be used to consider possible locations of wetland creation or enhancement. There are many components in addition to soil type that must be considered before moving forward with wetland design and creation. Additional information on wetlands can be found on the IDEM website http://www.in.gov/idem/wetlands/.

Table 12: Hydric Soils by County in the South Fork Blue River Watershed

Rural	Map Symbol	Hydric Soil Type	Acres
Washington	BO	Bonnie Silt Loam, Frequently Flooded	177
	PG	Peoga Silt Loam	412
	Ph	Peoga Silt Loam clayey Substratum	38
		Total	627
Scott	BodAW	Bonnie Silt Loam	5
		Total	5
Harrison	Mo	Montgomery Silty Clay Loam	48
		Total	48

Understanding Table 12: In the South Fork Blue River watershed, Washington County has the most acreage of hydric soils. Areas within these counties might contain opportunities for wetland restoration activities that could help address water quality impairments.

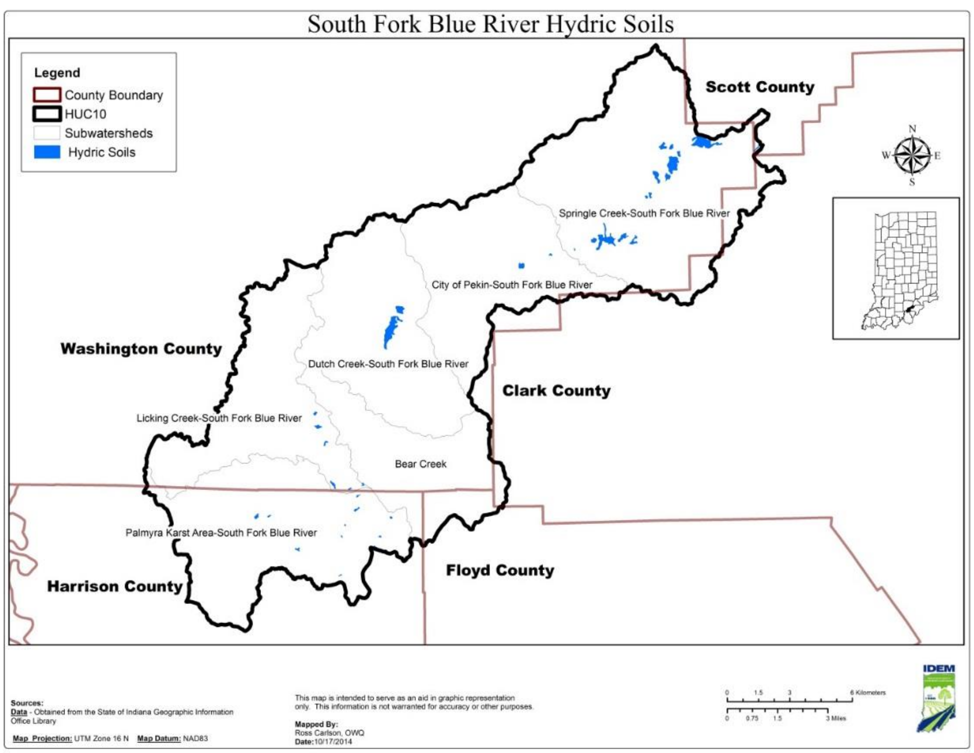

Figure 13: Hydric Soils in the South Fork Blue River Watershed

Nationally, since the late 1600s we have lost roughly 50% of the wetlands in the lower 48 states. Indiana has lost a large number of its wetlands. In the 1800s and 1900s millions of acres of wetlands were converted into farms, cities, and roads, and we converted wetlands to protect our health. Before the conversion of wetlands, there were over 5.6 million acres of wetlands in the state, wetlands such as bogs, fens, wet prairies, dune and swales, cypress swamps, marshes, and swamps. In the early 1700s, wetlands covered 25% of the total area of Indiana. That number has been greatly reduced. By the late 1980s over 4.7 million acres of wetlands had been lost - wetlands now cover less than 4% of Indiana. (http://www.in.gov/idem/wetlands/2335.htm)

Wetlands are home to wildlife. More than one-third (1/3) of America's threatened and endangered species live only in wetlands, which means they need them to survive. Over 200 species of birds rely on wetlands for feeding, nesting, foraging, and roosting. Wetlands provide areas for recreation, education, and aesthetics. More than 98 million people hunt, fish, birdwatch, or photograph wildlife. Americans spend $59.5 billion annually on these activities. (http://www.in.gov/idem/wetlands/2335.htm)

Wetland plants and soils naturally store and filter nutrients and sediments. Calm wetland waters, with their flat surface and flow characteristics, allow these materials to settle out of the water column, where plants in the wetland take up certain nutrients from the water. As a result, our lakes, rivers and streams are cleaner and our drinking water is safer. Man-made wetlands can even be used to clean wastewater, when properly designed. Wetlands also recharge our underground aquifers - over 70% of Indiana residents rely on ground water for part or all of their drinking water needs.(http://www.in.gov/idem/wetlands/2335.htm)

Wetlands protect our homes from floods. Like sponges, wetlands soak up and slowly release floodwaters. This lowers flood heights and slows the flow of water down rivers and streams. Wetlands also control erosion. Shorelines along rivers, lakes, and streams are protected by wetlands, which hold soil in place, absorb the energy of waves, and buffer strong currents. (http://www.in.gov/idem/wetlands/2335.htm)

Wetland areas act to buffer wide variations in flow conditions that result from storm events. They also allow water to infiltrate slowly thus reducing the risks of contaminated water runoff into waterbodies. Agencies such as the USGS and U.S. Fish and Wildlife Service (USFWS) estimate that Indiana has lost approximately 85% of the state's original wetlands (USGS, 1996) [5]. (See http://www.in.gov/dnr/fishwild/files/partner.pdf and https://pubs.usgs.gov/wsp/2425/report.pdf Currently, the South Fork Blue River watershed contains approximately 1,044 acres of wetlands or 1.26% of the total surface area (USFWS, 2003).

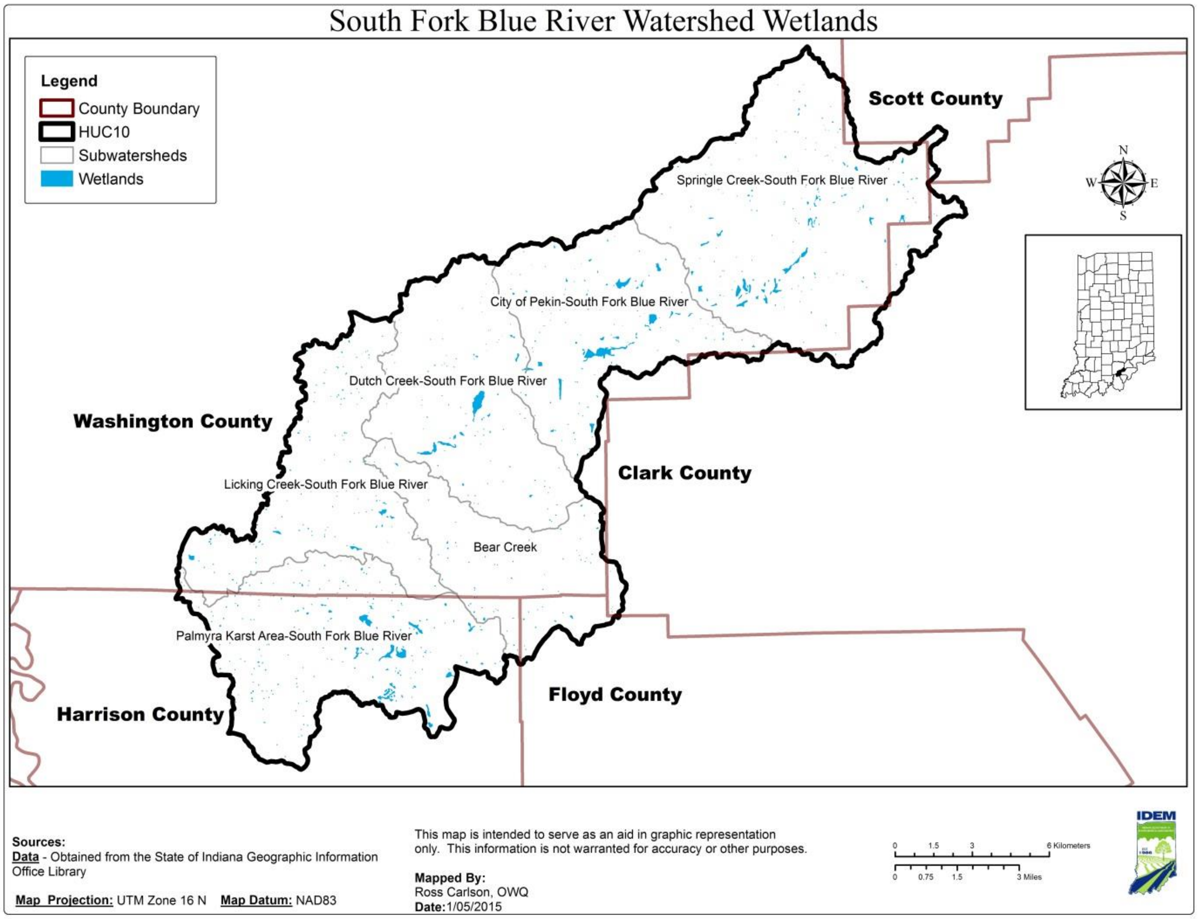

Figure 14: Location of Wetlands in the South Fork Blue River Watershed

The U.S. Fish and Wildlife Service (FWS) has the responsibility for mapping wetlands in the United States. Those map products are currently held in the Fish and Wildlife Service Wetland Database (sometimes referred to as the National Wetlands Inventory or NWI. Figure 14 shows estimated locations of wetlands as defined by the USFWS's NWI. Wetland data for Indiana is available from the U.S. Fish and Wildlife Service's NWI at https://www.fws.gov/wetlands/data/Mapper.html The NWI was not intended to produce maps that show exact wetland boundaries comparable to boundaries derived from ground soil surveys, and boundaries are generalized in most cases. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis. Therefore, the estimate of the current extent of wetlands in the South Fork Blue River Watershed from the NWI may not agree with those listed in Section 3.1 Land Use, which are based upon the MRLC dataset. For more information on the wetland classification codes visit http://www.fws.gov/wetlands/Data/Wetland-Codes.html. The U.S. Fish and Wildlife Service uses data standards to increase the quality and compatibility of its data.

Changes to the natural drainage patterns of a watershed are referred to as hydromodifications. Historically, drain tiles have been used throughout Indiana to drain marsh or wetlands and make them either habitable or tillable for agricultural purposes. While tile drainage is understood to be pervasive – estimated at thousands of miles in Indiana – it is extremely challenging to quantify on a watershed basis because these tiles were established by varying authorities including County Courts, County Commissioners, or County Drainage Boards. Records were not kept by private landowners as to the location and quantity of these tiles.

In addition to tile drainage, regulated drains are another form of hydromodification. A regulated drain is a drain which was established through either a Circuit Court or Commissioners Court of the County prior to January 1, 1966 or by the County Drainage Board since that time. Regulated drains can be an open ditch, a tile drain, stream, or a combination of the three. The County Drainage Board can construct, maintain, reconstruct or vacate a regulated drain. In the South Fork Blue River watershed, there are no open ditches under the jurisdiction of the any County Drainage Board.

3.4.4 Soil Erodibility

Although erosion is a natural process within stream ecosystems, excessive erosion negatively impacts the health of watersheds. Erosion increases sedimentation of the streambeds, which impacts the quality of habitat for fish and other organisms. Erosion also impacts water quality as it increases nutrients and decreases water clarity. As water flows over land and enters the stream as runoff, it carries pollutants and other nutrients that are attached to the sediment. Sediment suspended in the water blocks light needed by plants for photosynthesis and clogs respiratory surfaces of aquatic organisms.

The NRCS maintains a list of highly erodible lands (HEL) units for each county based upon the potential of soil units to erode from the land. https://efotg.sc.egov.usda.gov/references/public/NE/HEL_Intro.pdf HELs are especially susceptible to the erosional forces of wind and water. Wind erosion is common in flat areas where vegetation is sparse or where soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing productive top soil from one place and depositing it in another. The classification for HELs is based upon an erodibility index for a soil, which is determined by dividing the potential average annual rate of erosion by the soil unit's soil loss tolerance (T) value, which is the maximum annual rate of erosion that could occur without causing a decline in long-term productivity. The soil types and acreages in the South Fork Blue River Watershed are listed by county in Table 13. HELs and potential HELs in the South Fork Blue River Watershed are shown grouped together in Figure 15.

The data used to create Figure 15 was collected from the NRCS offices of Washington, Scott, Clark, Floyd, and Harrison Counties. A total of 48,469 acres or 60.1 percent of the South Fork Blue River watershed is considered highly erodible or potentially highly erodible. Rainfall within the South Fork Blue River Watershed is moderately heavy with an annual average of 49 inches. This rainfall and climate data specific to the watershed is available from the Indiana State Climate Office at Purdue University http://mrcc.isws.illinois.edu/CLIMATE/. Heavy rainfall increases flow rates within streams as the volume and velocity of water moving through the stream channels increases. Velocity of water also increases as streambank steepness increases.

Vegetation located adjacent to streams flowing through crop or pasture fields is often removed to promote drainage or cattle access to water. The loss of vegetation makes the streambanks more susceptible to erosion due to the loss of plant roots.

Extensive areas of agricultural tiles promote much quicker delivery of rainfall into streams than would occur without subsurface drainage, which could potentially contribute to streambank erosion due to high velocities and shear stress.

The creation of impervious surfaces (e.g., streets, rooftops, driveways, parking lots) can also lead to rapid runoff of rainfall and higher stream velocities that might cause streambank erosion.

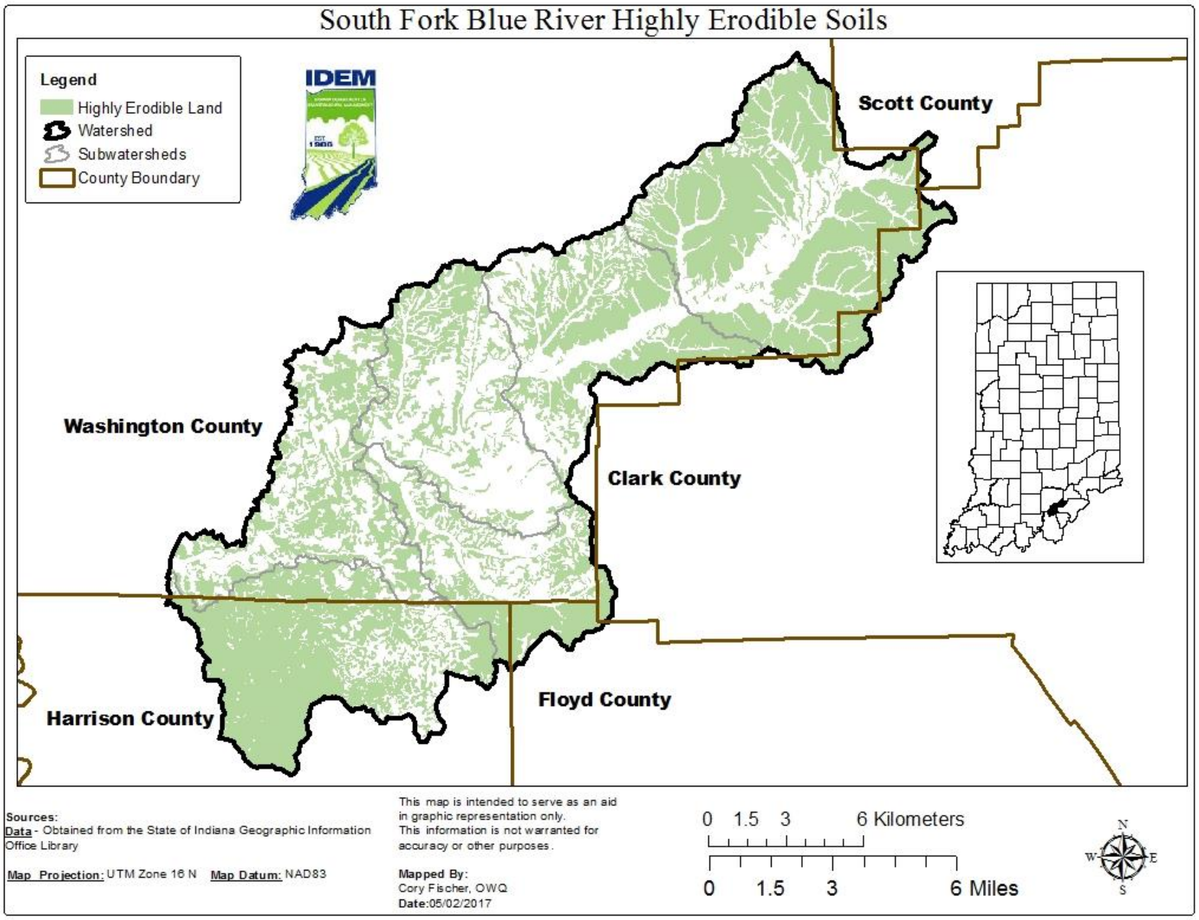

Figure 15: Location of Highly Erodible Lands (HEL) in the South Fork Blue River Watershed

Table 13: HEL/Potential HEL Total Acres in the South Fork Blue River Watershed

County	Map Symbol	HEL/Potential HEL Soil Types	Acres
Washington	BdB	Bedford Loam	5,065
	BhF	Berks-Weikert Complex	303
	CaE2	Caneyville-Hagerstown Silt Loam	863
	CdF	Caneyville-Rock outcrop Complex	492
	CtD2	Crider-Frederick Silt Loam	1,903
	CoD2	Crider Silt Loam	2,655
	EIB/EIC	Elkinsville Silt Loam	209
	FxC2	Frederick – Baxter Variant Complex, Karst	915
	FWD2	Fredrick Silt Loam, Karst	324
	GnF	Gilpin-Berks Loams	4,735
	GID2	Gilpin Silt Loam	330
	HeD2	Hagerstown-Caneyville Silt Loam	2,707
	HaC2	Hagerstown Silt Loam	155
	HhB	Haubstadt Silt Loam	1
	PeB/PeC2	Pekin Silt Loam	2,698
	Pt	Pits, Quarries	10
	Wa	Wakeland Silt Loam	456
	Wed/WeC2	Wellston Silt Loam	7,528
	ZaB/Zac2	Zanesville Silt Loam	2,400
		Total	33,749
Harrison	BeE2/Bfd2	Baxter Gravelly Silt Loam	1,035
	BpC3/BpD3/BmE3	Baxter Gravelly Silty Loam	3,292
	BcB2/BdB2/BdC2	Baxter Silt Loam	779
	BlB3/BtD5/Bkc3	Baxter Silty Loam	1,333
	BnB2/BnB3	Bedford Silt Loam	1,616
	CoF	Corydon-Rock Outcrop Complex	8
	CrB2/CsB3/CtC2/CtC3	Crider Silt Loam	2,838
	GpF	Gilpin-Berks Complex	1
	GlE2/GuD5	Gilpin Silt Loam	14
	HaE2/HaD2	Hagerstown Silt Loam	31
	HgC3/HgD3	Hagerstown Silty Clay Loam	86
	Peb2	Pekin Silt Loam	6
	TiB2	Tilsit Silt Loam	1
	WeD2/WeD3	Wellston Silt Loam	36
	ZaC2/ZaC3	Zanesville Silt Loam	3
		Total	11,079
Floyd	CtwB	Crider-Bedford-Navilleton Silt Loam	187
	KxpD2	Knobcreek-Haggatt-Caneyville Silt Loam	351
	KxoC2	Knobcreek-Navilleton-Haggatt Silt Loam	581
	MhyB2	Medora silt Loam	167

County	Map Symbol	HEL/Potential HEL Soil Types	Acres
	Ppu	Pits, Sand and Gravel	1
		Total	1,287
Clark	Ctwb	Crider-Bedford-Navilleton Silt Loam	130
	GgBg	Gilwood-Brownstown Silt Loam	795
	GgfE2/GgfD	Gilwood-Wrays Silt Loam	377
	GmaG	Gnawbone-Kurtz Silt Loam	46
	KxlC3/KxpD2	Knobcreek-Haggatt- Caneyville Silt Loam	69
	KxoC2	Knobcreek-Navilleton-Haggatt Silt Loam	143
	KxkC2	KnobCreek-Navilleton Silt Loam	212
	MhyB2	Medora Silt Loam	115
	PcrB2	Pekin Silt Loam	9
	SolC2	Spickert-Wrays Silt Loam	125
	SoaB	Spickert Silt Loam	15
		Total	4,610
Scott	BfcC3	Blocher Soft Bedrock	1
	BvoG	Brownstown-Gilwood Silt Loam	45
	CldC3	Cincinnati-Blocher Silt Loam	13
	CkkB2	Cincinnati silt Loam	22
	GgfD	Gilwood-Wrays Silt Loam	52
	NaaB2	Nabb Silt Loam	2
	PcrB2	Pekin Silt Loam	37
	SoaB	Pekin Silt Loam	10
	SoaC2	Spickert Silt Loam	80
	WedB2	Weddel Silt Loam	2
	WhcD	Wellrock-Gnawbone Silt Loam	9
		Total	273

Understanding Table 13: In the South Fork Blue River Watershed, Washington County has the most acreage of HEL/potential HEL soils. Areas within these counties might contribute to water quality impairments associated with excessive erosion, and might contain opportunities for restoration to decrease erosion.

The Indiana State Department of Agriculture (ISDA) tracks trends in conservation and cropland through annual county tillage transects. Data collected through the tillage transect county data found at https://secure.in.gov/isda/2383.htm help determine adoption of conservation practices and estimate the average annual soil loss from Indiana's agricultural lands. The 2013 figures for the counties in the South Fork Blue River Watershed are shown in Table 14. Tillage practices captured in ISDA's tillage transect include No-Till, Mulch Till, and conventional tillage practices. ISDA defines No-Till as any direct seeding system including site preparation, with minimal soil disturbance. Mulch Till is any tillage system leaving greater than 30 percent residue cover after planting, excluding no-till. Reduced tillage is a tillage system leaving 16 percent to 30 percent residue cover after planting. Conventional tillage is any tillage system leaving less than 15 percent residue cover after planting. (https://secure.in.gov/isda/files/Tillage_System_Definitions.pdf)

Table 14: Tillage Transect Data for 2013 by County in the South Fork Blue River Watershed

County	Tillage Practice 2013							
	No Till		Mulch Till		Reduced Till		Conventional Till	
	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn
Washington	39,600 ac. 87%	44,400 ac. 87%	1,400 ac. 3%	1,000 ac. 2%	900 ac. 2%	500 ac. 1%	3,600 ac. 8%	5,100 ac. 10%
Scott	16,500 ac. 79%	10,000 ac. 73%	2,100 ac. 10%	1,500 ac. 11%	0 ac. 0%	1,000 ac. 7%	2,100 ac. 10%	1,200 ac. 9%
Clark	25,400 ac. 80%	14,200 ac. 76%	600 ac. 2%	600 ac. 3%	300 ac. 1%	600 ac. 3%	5,400 ac. 17%	3,400 ac. 18%
Floyd	2,500 ac. 81%	2,300 ac. 75%	200 ac. 7%	100 ac. 4%	0 ac. 0%	0 ac. 0%	300 ac. 11%	700 ac. 21%
Harrison	24,800 ac. 94%	23,000 ac. 86%	0 ac. 0%	600 ac. 2%	1,100 ac. 4%	1,700 ac. 6%	500 ac. 2%	1,700 ac. 6%

Understanding Table 14: According to Table 14, No till is predominant in all counties in the South Fork Blue River watershed. The use of No Till is greatest in Harrison and Washington. These counties comprise 95% percent of the entire South Fork Blue River watershed.

3.5 Human Population

Counties with land located in the South Fork Blue River Watershed include Washington, Scott, Clark, Floyd, and Harrison Counties. Major government units with jurisdiction at least partially within the South Fork Blue River Watershed include New Pekin, Palmyra, and Fredericksburg. U.S. Census data for each county during the past three decades are provided in Table 15. Municipalities with a population of at least 1,000 are labeled in Figure 16.

Table 15: Population Data for Counties in South Fork Blue River Watershed

County	1990	2000	2010
Washington	23,717	27,223	28,262
Scott	20,991	22,960	24,181
Clark	87,777	96,472	110,232
Floyd	64,404	70,823	74,578
Harrison	29,890	34,352	39,364
TOTAL	***226,779***	***251,830***	***276,617***

Understanding Table 15: Water quality is linked to population growth because a growing population often leads to more development, translating into more houses, roads, and infrastructure to support more people. Table 15 provides information that shows how population has changed in each of the counties located in the South Fork Blue River Watershed over time. In addition, understanding population trends can help watershed stakeholders to anticipate where pressures might increase in the future and where action in the South Fork Blue River could help prevent further water quality degradation.

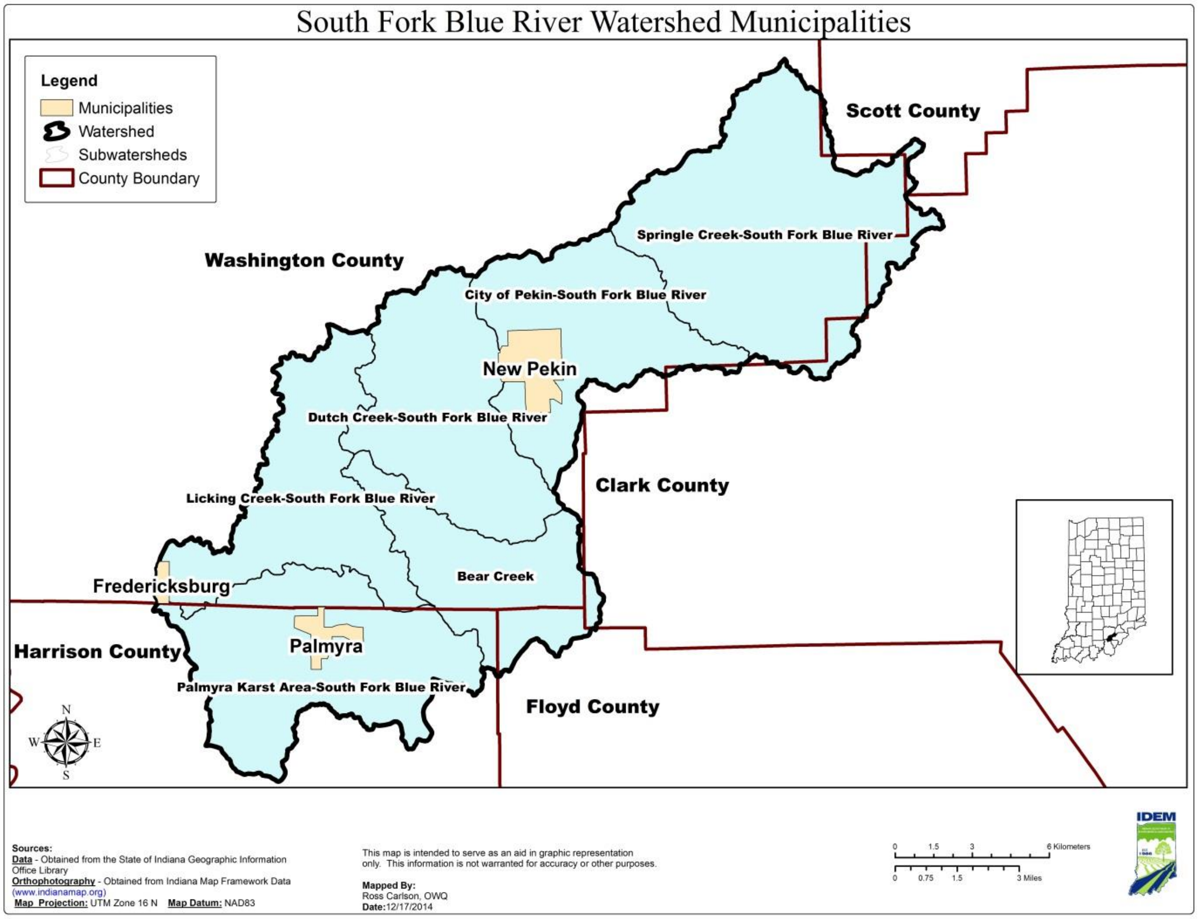

Figure 16: Municipalities in the South Fork Blue River Watershed

Estimates of population within South Fork Blue River Watershed are based on US Census data (2010) and the percentage of the total county and urban area that is within the watershed (Table 16). Based on this analysis, the estimated population of the watershed is 13,583 with approximately 83% of the population classified as rural residents and 17% classified as urban residents. Figure 17 indicates population density within the South Fork Blue River Watershed.

Table 16: Estimated Population in the South Fork Blue River Watershed

County	2010 Population	Total Estimated Watershed Population	Percent of Total Watershed Population	Non-urban Population	Urban Population
Clark	110,232	1,199	8.8%	1199	0
Floyd	74,578	899	6.6%	899	0
Harrison	39,364	2921	22.0%	2083	838
Scott	24,181	99	0.7%	99	0
Washington	28,262	8,465	62.3%	7029	1436
TOTAL	**276,617**	**13,583**	**100.0%**	**11,309**	**2,274**

Understanding Table 16: Understanding where the greatest population is concentrated within the South Fork Blue River Watershed will help watershed stakeholders understand where different types of water quality pressures might currently exist. In general, watersheds with large urban populations are more likely to have problems associated with lots of impervious surfaces, poor riparian habitat, flashy storm water flows, and large wastewater inputs. Alternatively, watersheds with mostly a non-urban population are more likely to suffer problems from failing septic systems, agricultural runoff, and other types of poor riparian habitat (e.g., channelized streams). Comparing the information in Table 15 with the information in Table 16 can provide an understanding of how population might change in the South Fork Blue River Watershed and which counties are experiencing the most growth and shifts in urban and non-urban population. Population change can serve as an indicator for changes in land uses. For example, growing populations might mean more development, resulting in increased impervious surfaces and more infrastructure (e.g., sanitary sewer and storm sewer). Declining population in areas of the South Fork Blue River Watershed might signify communities with under-utilized infrastructure and indicate opportunities to “rightsize” existing infrastructure and promote changes to land use that would benefit water quality (e.g., green infrastructure).

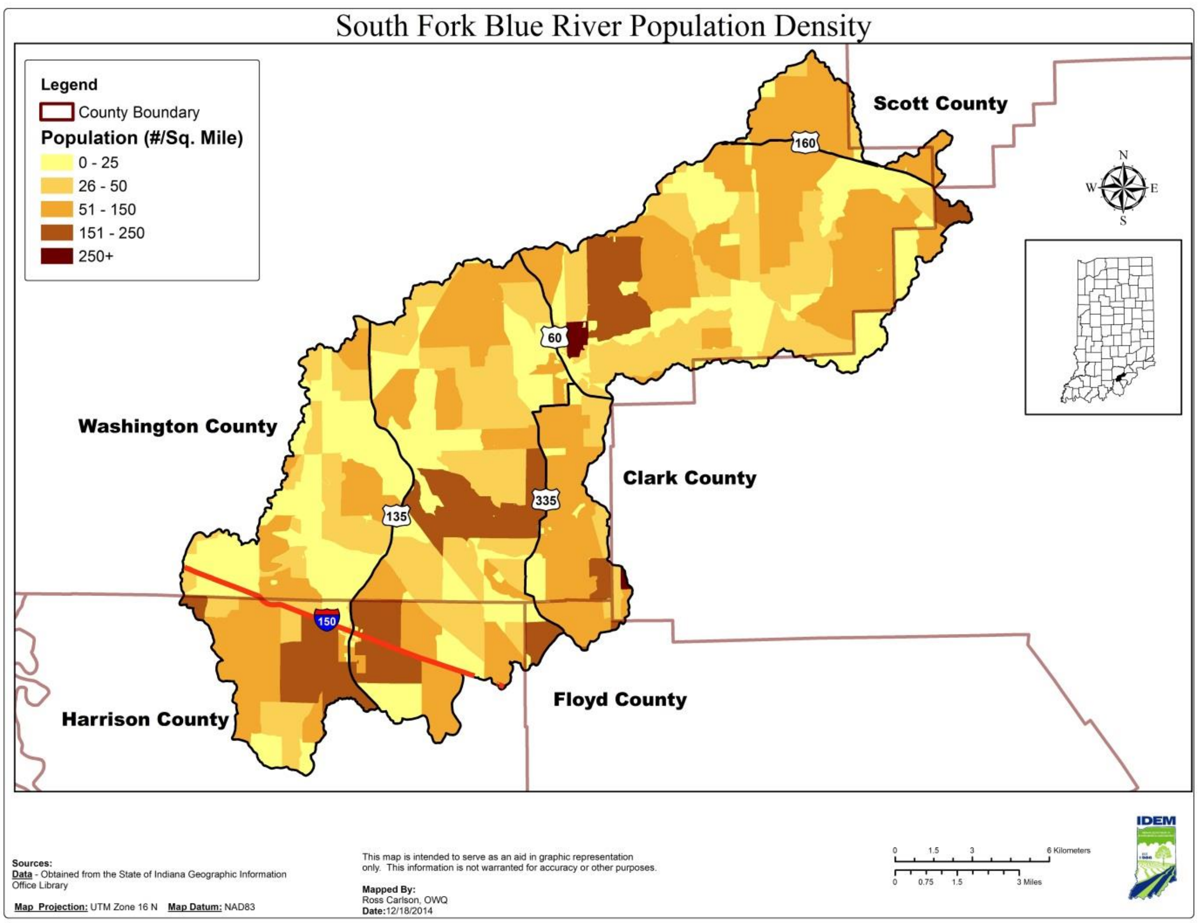

Figure 17: Population Density in the South Fork Blue River Watershed

3.6 Urban Storm water

In areas not covered under the NPDES Municipal Separate Storm Sewer System (MS4) program, storm water runoff from developed areas is not regulated under a permit and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Typically urban sources of nutrients are fertilizer application to lawns and pet waste, which is also a source of *E. coli*. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the South Fork Blue River Watershed is discussed in Section 3.1 Land Use However, inputs from urban sources are difficult to quantify. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the South Fork Blue River Watershed.

3.7 Wildlife and Classified Lands

Wildlife such as deer, raccoon, waterfowl, and riparian small mammals (e.g., beaver, otter) can be sources of bacteria. The animal habitat and proximity to surface waters are important factors that determine if animal waste can be transported to surface waters. Waterfowl and riparian mammals deposit waste directly into streams while other riparian species deposit waste in the floodplain, which can be transported to surface waters by runoff from precipitation events. Animal waste deposited in upland areas can also be transported to streams and rivers; however, due to the distance from uplands to surface streams, only larger precipitation events can sustain sufficient amounts of runoff to transport upland animal waste to surface waters.

3.7.1 Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli* throughout the South Fork Blue River Watershed. Little information exist surrounding feces depositional patterns of wildlife and a direct inventory of wildlife populations is generally not available. However, based on the *Bacteria Source Load Calculator* developed by the Center for TMDL and Watershed Studies, bacteria production by animal type is estimated as well as their preferred habitat. Higher concentrations of wildlife in the habitats described in Table 17 could contribute *E. coli* to the watershed, particularly during high flow conditions or flooding events.

Table 17: Bacteria Source Load by Species

Wildlife Type	*E. coli* Production Rate (cfu/day – animal)	Habitat
Deer	1.86×10^8	Entire Watershed
Raccoon	2.65×10^7	Low density on forests in rural areas; high density on forest near a permanent water source or near cropland
Muskrat	1.33×10^7	Near ditch, medium sized stream, pond or lake edge
Goose	4.25×10^8	Near main streams and impoundments

Wildlife Type	*E. coli* Production Rate (cfu/day – animal)	Habitat
Duck	1.27×10^9	Near main streams and impoundments
Beaver	2.00×10^5	Near streams and impoundments in forest and pastures

3.7.2 Classified Lands

Managed lands, shown in, Table 18 include natural and recreation areas which are owned or managed by the Indiana Department of Natural Resources, federal agencies, local agencies, non-profit organizations, and conservation easements. Classified lands are public or private lands containing areas supporting growth of native or planted trees, native or planted grasses, wetlands or other acceptable types of cover that have been set aside for managed production of timber, wildlife habitat, and watershed protection. Natural areas provide ideal habitat for wildlife. Some of the more common wildlife often found in natural areas include white-tailed deer, raccoon, muskrat, fowl and beaver. While wildlife is known to contribute *E. coli* to the surface waters, natural areas provide economic, ecological and social benefits and should be preserved and protected. Management practices such as reducing impervious surfaces, native vegetation plantings, wetland creation and riparian buffers will help in reducing storm water runoff transporting pollutants to the streams. Table 18 and Figure 18 show the managed lands within the South Fork Blue River Watershed. Table 19 and Figure 18 show the managed and classified lands within South Fork Blue River Watershed.

Table 18: Managed Lands within the South Fork Blue River Watershed

Unit Name	Manager	Area (acres)
Big Spring Nature Preserve	DNR Nature Preserves	10
Clark State Forest	DNR Forestry	24626
Charles Spring	The Nature Conservancy	416
Charles Spring Nature Preserve	DNR Nature Preserves	106
Big Spring Farm Forest Legacy Area	Private Landowner	184
Dr. Clapp Barrens	Private Landowner	68
Buffalo Trace Park	Palmyra Park Board	133
	Total	**25,543**

Table 19: Classified Lands within the South Fork Blue River Watershed

Classified Lands (Acres)						
Subwatershed	**Grassland**	**Woodland**	**Scrubland**	**Wetland**	**Other**	**Total**
Springle Creek	0	817	0	0	0	**817**
City of Pekin	26	429	5	0	0	**460**
Bear Creek	0	342	0	0	0	**342**
Dutch Creek	0	496	0	0	0	**496**
Palmyra Karst Area	0	393	0	0	0	**393**
Licking Creek	7	870	0	0	0	**877**
					Total	**3,385**

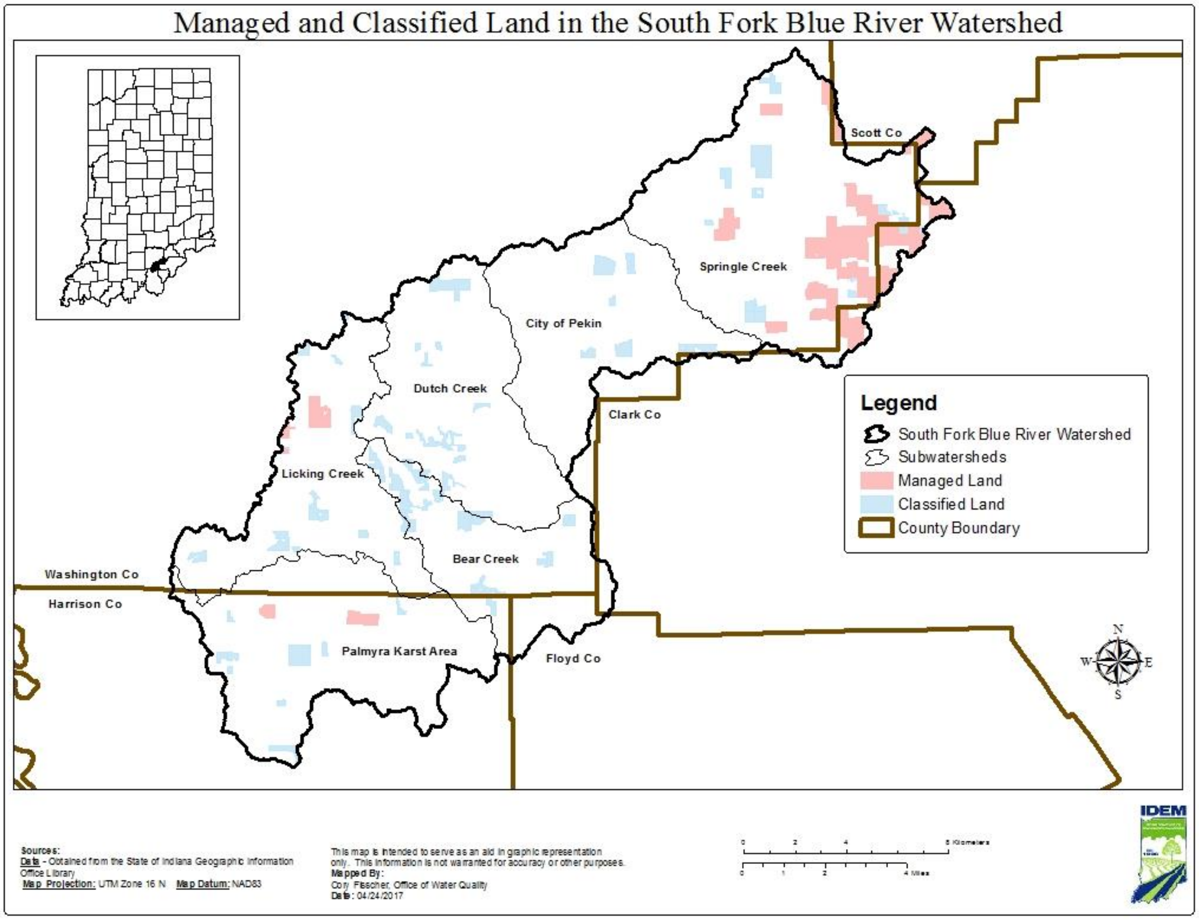

Figure 18: Managed and Classified Lands within the South Fork Blue River Watershed

3.8 Climate and Precipitation

Climate varies in Indiana depending on latitude, topography, soil types, and lakes. Information on Indiana's climate is available through sources including the Indiana State Climate Office at Purdue University http://mrcc.isws.illinois.edu/CLIMATE/

Climate data from National Weather Service (NWS) Co-operative Station Number 154955, located in Louisville Kentucky were used for climate analysis of the South Fork Blue River Watershed. Monthly data from 1948 – current were available at the time of analysis, and 1995-2015 were used in the analysis. From 1995-2015, the average winter temperature in Louisville was 37°F and the average summer temperature was 78°F. The average growing season (consecutive days with low temperatures greater than or equal to 32 degrees) is 170 days.

Examination of precipitation patterns is also a key component of watershed characterization because of the impact of runoff on water quality. From 1995-2015, the annual average precipitation in Louisville at Station 154955 was approximately 49 inches.

Rainfall intensity and timing affect watershed response to precipitation. This information is important in evaluating the effects of storm water on the South Fork Blue River Watershed. Using data from 154955 during 1995-2015, 52 percent of the measureable precipitation events were very low intensity (i.e., less than 0.2 inches), while 11 percent of the measurable precipitation events were greater than one inch.

Understanding when precipitation events occur helps in the linkage analysis (Section 5.0 Linkage Analysis), which correlates flow conditions to pollutant concentrations and loads. Data indicates that the wet weather season in the South Fork Blue River Watershed occurs between the months of March and May.

3.9 Point Sources

This section summarizes the potential point sources of *E. coli* in the South Fork Blue River Watershed, as regulated through the NPDES Program.

3.9.1 Wastewater Treatment Plants (WWTPs)

Wastewater treatment facilities have NPDES permits to discharge wastewater within the South Fork Blue River Watershed. There are two active WWTPs that have the potential to discharge wastewater containing *E. coli* within the South Fork Blue River (Table 20 and Figure 19). As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating WWTPs that discharge pollutants into waters of the United States.

Municipal facilities in Indiana are required to disinfect their effluent during the recreational season (April 1 to October 31). However, in accordance with 327 IAC 5-10-4(c), the Town of Palmyra WWTP effluent shall be disinfected on a continuous year-round basis since the discharge goes directly to a sinkhole.

The Town of Palmyra (IN0039403) currently owns and operates a Class I, 0.14 Million Gallons per Day (MGD) Biolac activated sludge-type treatment facility consisting of a submersible grinder, a parshall flume influent flow meter, two (2) manually-cleaned bar screen, a lined biolac-earthen lagoon (40 hour detention time) with aeration equipment consisting of three trains, with four (4) diffusers each, two (2) secondary clarifiers, an ultraviolet light disinfection system, a post aeration tank, and a rectangular weir-type effluent flow meter. Sludge handling includes three (3) aerobic digesters and two (2) sludge drying beds. Biosolids are land applied. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. The facility discharges into Cedar Springs sink hole via outfall 001. There is no significant industrial flow into the Town of Palmyra WWTP; the NPDES permit doesn’t authorize the facility to accept industrial contributions until the permittee has provided IDEM with a characterization of the waste.

The Town of New Pekin (IN0021059) currently operates a Class I-SP, 0.18 MGD controlled discharge waste stabilization lagoon facility consisting of two (2) lagoon cells totaling 13.25 acres in size, an influent flow meter, and effluent flow meter, and a stream gauge. The Town also has effluent chlorination facilities present at the wastewater treatment facility which are not required to be utilized at this time unless necessary to achieve compliance with the *E. coli* limitations. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. The facility discharges into the Muddy Fork of the South Fork Blue River via Outfall 001. The receiving water has a seven day, ten year low flow ($Q_{7, 10}$) of 0.0 cubic feet per second at the outfall location. There is no significant industrial flow into the Town of New Pekin WWTP; the NPDES permit doesn’t authorize the facility to accept industrial contributions until the permittee has provided IDEM with a characterization of the waste. Pursuant to 327 IAC 5-10-3(a) municipal wastewater treatment facilities with multiple cell waste stabilization ponds operating as controlled discharges may discharge at any time provided effluent limits and all conditions of the permit are met and the daily discharge flow rate does not exceed one-tenth (1/10) of the stream flow of the receiving stream.

Table 20: NPDES Permitted Wastewater Treatment Plants Discharging within the South Fork Blue River Subwatersheds

Subwatershed	Facility Name	Permit Number	AUID	Receiving Stream	Design Flow (MGD)	*E. coli* Concentration (Daily Maximum)
Palmyra Karst Area	Palmyra WWTP	IN0039403	NA	Cedar Spring Sink Hole	0.14	235 cfu/100mL
City of Pekin	New Pekin WWTP	IN0021059	INN0462_T1013	Muddy Fork	(1/10) Stream Flow	235 cfu/100mL

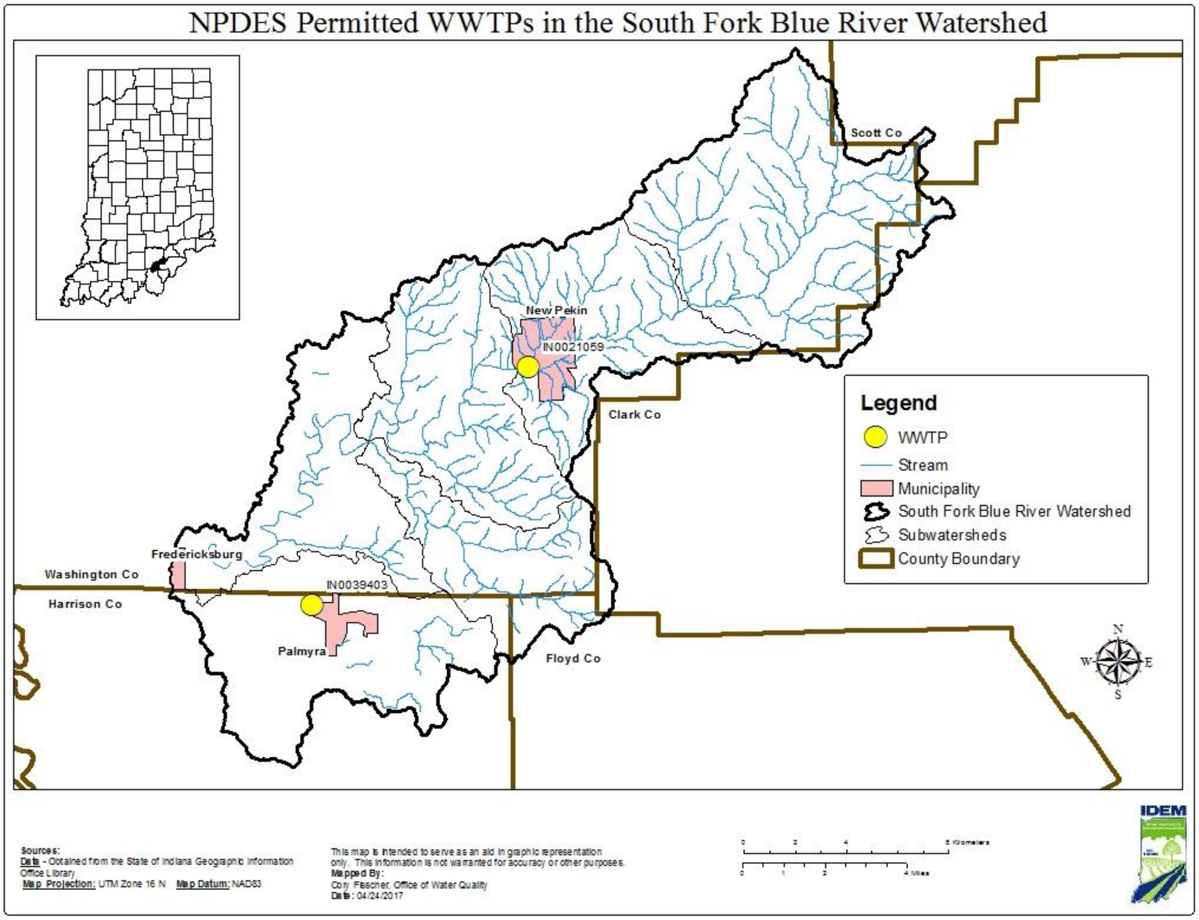

Figure 19: NPDES Permitted Wastewater Treatment Plants Discharging within the South Fork Blue River Subwatersheds

Table 21 presents a summary of permit compliance for all NPDES facilities in the South Fork Blue River Watershed for the period between 2010-2017. It presents the date of the inspection and findings from the inspection (i.e., compliance or violation for facility maintenance). The table also presents the total number of violations in the same period for *E. coli*. While there are some inspection issues noted, these do not necessarily directly relate to effluent violations for *E. coli*.

Table 21: Summary of Inspections and Permit Compliance in the South Fork Blue River Watershed

Subwatershed	Facility Name	Permit Number	Stream	Date of Inspection for the Last Five Years	*E. coli* Violations for the Last Five Years			
					Quarter	Year	Parameter	Exceedance
City of Pekin	New Pekin Municipal WWTP	IN0021059	South Fork Blue River	11/18/2016: Potential Problems 3/24/2016: Violations were Observed 3/20/2015: Potential Problems 3/25/2014: Potential Problems 1/07/2013: Violations Observed 9/04/2012: Violations Observed 9/19/2011: Violations Observed	N/A	N/A	N/A	N/A
Palmyra Karst	Palmyra Municipal WWTP	IN0039403	Blue River Via Sink Hole	2/09/2017: No violations 6/03/2016: No violations 5/11/2015: Potential Problems 8/04/2014: Potential Problems 12/20/2010: No Violations	1	2012	*E. coli*	377%

3.10 Summary

The information presented in Section 3 helps to provide a better comprehensive understanding of the conditions and characteristics in the South Fork Blue River watershed that, when coupled with the sources presented in Section 4, affect both water quality and water quantity. In summary, the predominant land uses in the South Fork Blue River watershed of forest and agriculture serve as indicators as to the type of sources that are likely to contribute to water quality impairments in the South Fork Blue River watershed. Human population, which is greatest in Washington County in the South Fork Blue River watershed, indicates where more infrastructure related pressures on water quality might exist. There are two NPDES wastewater treatment plants within South Fork Blue River that have the potential to cause or contribute to *E. coli* impairments. The subsections on topography and geology, as well as soils, provide information on the natural features that affect hydrology in the South Fork Blue River watershed. These features interact with land use activities and human population to create pressures on both water quality and quantity in the South Fork Blue River watershed. Lastly, the subsection on climate and precipitation provides information on water quantity and the factors that influence flow, which ultimately affects the influence of storm water on the watershed. Collectively, this information plays an important role in understanding the sources that contribute to water quality impairment during TMDL development and crafting the linkage analysis that connects the observed water quality impairment to what has caused that impairment.

4.0 TECHNICAL APPROACH

Previous sections of the report have provided a description of the South Fork Blue River watershed and summarized the applicable water quality standards, water quality data, and identified the potential sources of pollutants for assessment units in each subwatershed. This section presents IDEM's technical approach for using water quality sampling data and flow data for each subwatershed to estimate the current allowable loads of pollutants in each subwatershed. This section focuses on describing the methodology and is helpful in understanding subsequent sections of the TMDL report.

4.1 Load Duration Curves

To determine allowable loads for the TMDL, IDEM uses a load duration curve approach. This approach helps to characterize water quality problems across flow conditions and provide a visual display that assists in determining whether loadings originate from point or nonpoint sources. Load duration curves present the frequency and magnitude of water quality violations in relation to the allowable loads, communicating the magnitude of the needed load reductions.

Developing a load duration curve is a multi-step process. To calculate the allowable loadings of a pollutant at different flow regimes, the load duration curve approach involves multiplying each flow by the TMDL target value or Water Quality Standard and using the appropriate conversion factor. The steps are as follows:

- A flow duration curve for the stream is developed by generating a flow frequency table and plotting the observed flows in order from highest (left portion of curve) to lowest (right portion of curve).
- The flow curve is translated into a load duration (or TMDL) curve. To accomplish this, each flow value is multiplied by the TMDL target value or Water Quality Standard with the appropriate

conversion factor and the resulting points are graphed. Conversion factors are used to convert the units of the target (e.g., #/100 mL for *E. coli*) to loads (e.g., G-org/day for *E. coli* [G-org=1E+09 organisms]) with the following factors used for this TMDL:

- *E. coli*: Flow (cfs) x TMDL Concentration Target (#/100mL) x Conversion Factor (0.024463) = Load (G-org/day)
- To estimate existing loads, each water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected and the appropriate conversion factor. Then, the existing individual loads are plotted on the TMDL graph with the curve.
- Points plotting above the curve represent violations of the applicable water quality standard or exceedances of the applicable target and the daily allowable load. Those points plotting at or below the curve represent compliance with standards and the daily allowable load.
- The area beneath the load duration curve is interpreted as the loading capacity of the stream. The difference between this area and the area representing the current loading conditions above the curve is the load that must be reduced to meet water quality standards.

The load duration curve approach can consider seasonal variation in TMDL development as required by the CWA and USEPA's implementing regulations. Because the load duration curve approach establishes loads based on a representative flow regime, it inherently considers seasonal variations and critical conditions attributed to flow conditions. Some TMDLs focus on capturing the magnitude of the highest observed exceedance. However, such TMDLs may be overly protective of the water quality standard, potentially inviting issues regarding reasonable assurance. Alternatively, some TMDLs focus on the average or median flow exceedance value, potentially resulting in allocations that are not protective enough during higher flow events. For this reason it is appropriate to apply the entire duration curve in the context of a TMDL. Another option is to categorize the duration curve into several zones, allowing the resultant TMDL to adequately capture different types of flow events (USEPA, 2007).

The stream flows displayed on water quality or load duration curves may be grouped into various flow regimes to aid with interpretation of the load duration curves. The flow regimes are typically divided into the following five "hydrologic zones" (USEPA, 2007):

- Very High Flows: Flows in this range represent flooding or near flooding stages of a stream. These flows are exceeded 0 – 10 percent of the time.
- Moist Zone: Flows in this range are related to wet weather conditions. These flows are exceeded 10 – 40 percent of the time.
- Mid-Range Zone: Flows in this range represent median stream flow conditions. These flows are exceeded 40 – 60 percent of the time.
- Dry Zone: Flows in this range are related to dry weather flows. These flows are exceeded 60 -90 percent of the time.
- Very Low Flows: Flows in this range are seen in drought-like conditions. These flows are exceeded 90 -100 percent of the time.

The load duration curve approach helps to identify the sources contributing to the impairment and to roughly differentiate between sources. Exceedances of the load duration curve at higher flows (0-40 percent ranges) are indicative of wet weather sources (e.g., nonpoint sources, regulated storm water discharges). Exceedances of the load duration curve at lower flows (60 to 100 percent range) are indicative of point source sources (e.g., wastewater treatment facilities, livestock in the stream). Table 22 summarizes the general relationship between the five hydrologic zones and potentially contributing source areas (the table is not specific to any individual pollutant). For example, the table indicates that impacts from wastewater treatment plants are usually most pronounced during dry and low flow zones because there is less water in the stream to dilute their loads. In contrast, impacts from channel bank erosion is most pronounced during high flow zones because these are the periods during which stream velocities are high enough to cause erosion to occur.

Table 22: Relationship between Load Duration Curve Zones and Contributing Sources

	Duration Curve Zone				
Contributing Source Area	**High (0%-10%)**	**Moist (10%-40%)**	**Mid-Range (40%-60%)**	**Dry (60%-90%)**	**Low (90%-100%)**
Wastewater treatment plants			L	M	H
Livestock direct access to streams			L	M	H
Wildlife direct access to streams			L	M	H
Pasture Management	H	H	M		
On-site wastewater systems/Unsewered Areas	L	M	H	H	H
Riparian Buffer areas	H	H	M	M	
Abandoned mines	H	H	H	H	H
Storm water: Impervious	H	H	H		
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M	L	
Bank erosion	H	M	L		

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)

Modified from (EPA, 2007 An Approach for Using Load Duration Curves in the Development of TMDLs)

4.2 Stream Flow Estimates

Daily stream flows are necessary to implement the load duration curve approach. Load duration assessment locations in the South Fork Blue River watershed were chosen based on the location of the impaired stream segments and the availability of water quality samples to estimate existing loads.

The USGS does not operate any stream flow gaging stations in the South Fork Blue River watershed. Since there are no continuous flow data for the South Fork Blue River watershed, flow data were estimated for the South Fork Blue River watershed using flow data from a neighboring "surrogate" watershed. This is a standard practice when developing TMDLs for ungaged watersheds and is appropriate when the two watersheds are located close to one another and have similar land use and soil characteristics.

The USGS gage for the Blue River near Fredericksburg (03302800) located just downstream of the confluence of the South Fork Blue River and the Blue River was used for the development of the *E. coli* load duration curve analysis for the South Fork Blue River watershed TMDL. USGS gage 03302800 is located in Washington County. Gage 03302800 drains approximately 283 sq. miles in the Blue-Sinking

(HUC 8: 05140104) watershed, 126 miles of the drainage area to Gage 03302800 is the South Fork Blue River watershed as shown in Figure 20.

Table 23: USGS Site Assignment for Development of Load Duration Curve

Gage Location	Gage ID	Period of Record
Blue River at Fredericksburg	03302800	1968-2017

Since the load duration approach requires a stream flow time series for each site included in the analysis, stream flows were extrapolated from USGS gage 03302800 for each assessment location by using a multiplier based upon the ratio of the upstream drainage area for a given location to the drainage area of the South Fork Blue River watershed.

Flows were estimated using the following equation:

$$Q_{ungaged} = \frac{A_{ungaged}}{A_{gaged}} \times Q_{gaged}$$

Where,

$Q_{ungaged}$:	Flow at the ungaged location
Q_{gaged}:	Flow at surrogate USGS gage station
$A_{ungaged}$:	Drainage area of the ungaged location
A_{gaged}:	Drainage area of the gaged location

In this procedure, the drainage area of each of the load duration stations was divided by the drainage area of the surrogate USGS gage. The flows for each of the stations were then calculated by multiplying the flows at the surrogate gage by the drainage area ratios. Additional flows were added to certain locations to account for municipal wastewater treatment plants that discharge upstream and are not directly reflected in the load duration curve method. Table 24 summarizes a portion of individual monthly mean flow values using USGS data for the Blue River near Fredericksburg. Summary statistics for each month using the period 1995-2015 are included at the bottom of Table 24.

As seen in Table 24, seasonal patterns reflect higher flows in spring (March – May) and early winter (December, January) with a transition to lower flows in summer months (July-August). However, interannual variation is another factor to consider when identifying loading capacities. Average values for the same month can vary by as much as an order of magnitude due to varying weather conditions (e.g., an unusually dry December or an abnormally wet June), as shown in Table 24 for the South Fork Blue River. Table 25 presents the Key Flow percentiles that are used to calculate the loadings for the TMDL in each subwatershed. This number represents the midpoint for each hydrologic zone.

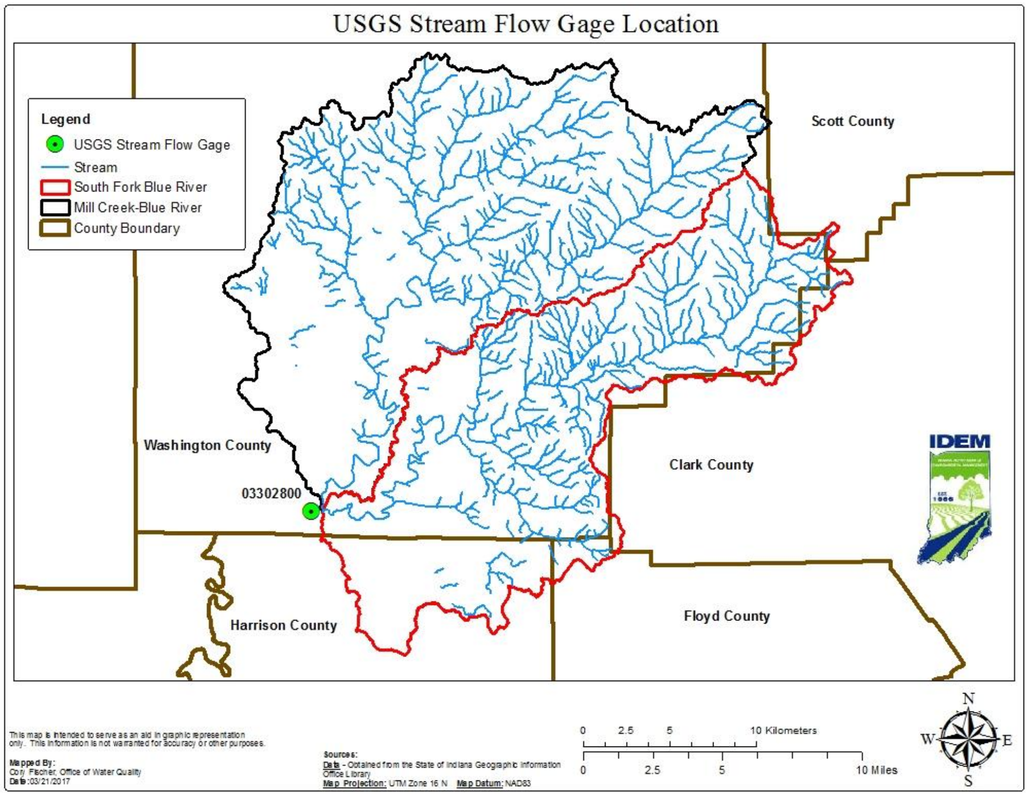

Figure 20: Location of Surrogate Flow Gage for the South Fork Blue River Watershed

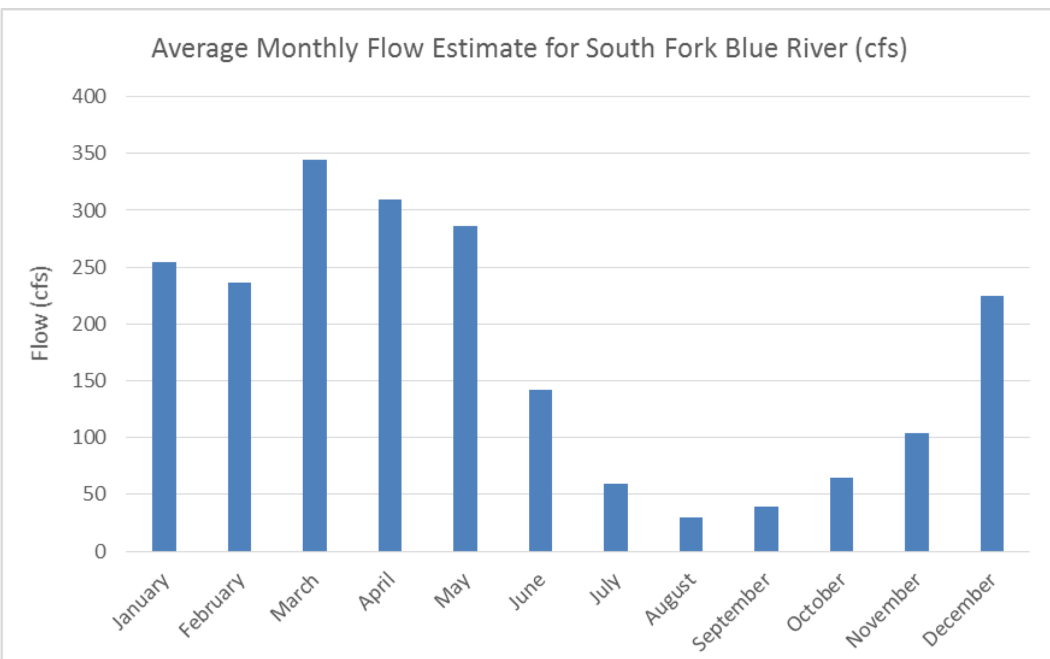

Figure 21: Average Monthly Flow Estimate for South Fork Blue River

Table 24: South Fork Blue River Estimated Monthly Mean Flows (cfs)

	South Fork Blue River Estimated Monthly Mean Flows (cfs)											
	January	February	March	April	May	June	July	August	September	October	November	December
1995	161	162	169	124	641	144	45	82	6	6	13	79
1996	325	95	379	871	631	345	48	19	133	44	75	388
1997	233	225	611	115	301	529	30	10	5	2	6	43
1998	88	198	211	335	280	125	45	42	4	4	7	59
1999	479	262	263	132	89	54	41	4	2	3	3	17
2000	248	472	192	180	72	92	32	46	46	18	53	231
2001	56	293	100	37	29	89	24	14	49	206	237	580
2002	144	209	401	370	594	117	13	6	39	31	131	195
2003	199	311	227	264	427	81	38	10	24	30	163	145
2004	396	234	172	186	796	141	98	42	8	69	345	221
2005	733	194	204	140	68	69	12	18	8	4	146	96
2006	316	182	675	268	117	135	124	27	169	194	242	295
2007	444	212	196	282	114	16	20	4	4	23	26	356
2008	136	448	1260	365	316	49	32	14	24	7	12	167
2009	74	260	92	160	157	295	136	196	197	514	106	123
2010	180	222	193	158	321	64	17	5	2	3	63	63
2011	79	290	378	972	552	184	52	11	12	9	185	562
2012	396	124	356	116	163	23	9	4	10	12	9	84
2013	282	174	359	165	122	226	53	7	8	56	127	360
2014	186	311	157	641	185	39	44	46	67	112	70	212
2015	193	71	634	625	38	168	335	16	5	18	172	439
Maximum	4,587	4,676	12,158	9,797	7,571	3,198	2,017	1,474	1,879	4,266	3,042	4,676
Average	255	236	344	310	286	142	59	30	39	65	104	225
Minimum	4	16	36	19	13	4	5	2	1	1	1	3

Table 25: Load Duration Curve Key Flow Percentile Estimates

Subwatershed	Drainage Area (sq. miles)	Flow Duration Exceedance Interval Flows (cfs)				
		High (5%)	Moist (25%)	Mid-Range (50%)	Dry (75%)	Low (95%)
Springle Creek	32	165	45	16	4	1
City of Pekin	52	261	71	26	7	2
Bear Creek	14	70	19	7	2	0.4
Dutch Creek	71	359	97	35	9	2
Palmyra Karst Area (captured in Licking Creek)	NA	NA	NA	NA	NA	NA
Licking Creek	126	637	172	62	16	4

4.3 Margin of Safety (MOS)

Section 303(d) of the Clean Water Act and USEPA regulations at 40 CFR 130.7 require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a MOS which takes into account any lack of knowledge concerning the relationship between limitations and water quality." USEPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). This TMDL uses both an implicit and explicit MOS. An implicit MOS was used by applying a couple of conservative assumptions. A moderate explicit MOS has been applied by reserving ten percent of the allowable load. Ten percent was considered an appropriate MOS based on the following considerations:

- The use of the load duration curve approach minimizes a great deal of uncertainty associated with the development of TMDLs because the calculation of the loading capacity is simply a function of flow multiplied by the target value. Most of the uncertainty is therefore associated with the estimated flows in each assessed segment which were based on extrapolating flows from the nearest downstream USGS gage.
- An additional implicit MOS for *E. coli* is included because the load duration analysis does not address die-off of pathogens.
- An additional implicit MOS for *E. coli* is included because the NPDES WLAs were calculated using the maximum design discharge. NPDES facilities routinely discharge below their maximum design discharge.

4.4 Future Growth Calculations

Population trends are indicating that this watershed has been increasing (Table 15) over the past two decades, and uncertainty in future populations in the South Fork Blue River Watershed have led IDEM to choose to allocate 5% of the loading capacity toward future growth. IDEM anticipates that land uses will likely be changing in the watershed in the future and in anticipation of those land use changes has set aside 5% of the loading capacity to address increased bacteria loads from those future contributors.

5.0 Linkage Analysis

A linkage analysis connects the observed water quality impairment to what has caused that impairment. An essential component of developing a TMDL is establishing a relationship between the source loadings and the resulting water quality. Potential point and nonpoint sources are inventoried in Section 3.0 and water quality data within the South Fork Blue River watershed are discussed in Section 5.0. The purpose of this section of the report is to evaluate which of the various potential sources is most likely to be contributing to the observed water quality impairments

5.1 Linkage Analysis for *E. coli*

Establishing a linkage analysis for *E. coli* is challenging because there are so many potential sources and *E. coli* counts have a high degree of variability. While it is difficult to perform a site-specific assessment of the causes of high *E. coli* for each location in a watershed, it is reasonable to expect that general patterns and trends can be used to provide some perspective on the most significant sources.

Load duration curves were created for the sampling sites in the South Fork Blue River watershed that were sampled by IDEM in 2015. The load duration curve method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and nonpoint). Section 4.1 summarizes the load duration curve approach. This section discusses the load duration curves and the linkage between the potential sources in the South Fork Blue River watershed and the observed water quality impairment.

To further investigate sources, *E. coli*/precipitation graphs have been created. Elevated levels of *E. coli* during rain events indicate *E. coli* contribution due to runoff. The precipitation data was taken from a weather station in Louisville, Kentucky and managed by the Indiana State Climate Office at Purdue University.

E. coli sources typically associated with high flow and moist conditions include failing onsite wastewater systems, urban storm water, runoff from agricultural areas, and bacterial re-suspension from the streambed. *E. coli* sources typically associated with low flow conditions include a large number of homes on failing or illicitly connected septic systems that would provide a constant source. Elevated *E. coli* levels at low flow could also result from inadequate disinfection at wastewater treatment plants or animals with direct access to streams.

5.2 Linkage Analysis by Subwatershed

The following sections discuss the load duration curves, precipitation graphs and linkage of sources to the water quality exceedances for each subwatershed.

5.2.1 Springle Creek Subwatershed

The Springle Creek subwatershed drains approximately 33 square miles. The subwatershed forms the uppermost main stem of the South Fork Blue River in the northeast portion of the watershed. The land use is primarily forested (65%) followed by hay and pasture land (21%) and agricultural (10%). There are no permitted facilities, WWTPs, or industrial storm water permits in the subwatershed. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. Despite its flat nature the subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration. With a land use of approximately 20 percent pasture land a heavy presence of pasture animals is expected, many of which could have direct access to the stream corridor. There is also one regulated CFO in the subwatershed that may be land applying manure that could contribute to high levels of *E. coli*.

There are six sampling sites located in the Springle Creek Subwatershed, one located on Honey Run OBS-06-0011 (19), two located on Jeff Branch OBS-06-0003 (16) and OBS-06-0019 (18), two sites on South Fork Blue River OBS-06-0002 (17) and OBS-06-0010 (21) and one located on Springle Creek OBS-06-0005 (20). In 2015 this watershed was sampled monthly resulting in sites failing the WQS for *E. coli* and IBC. Site OBS-06-0019 (18) was the only site to be fully supporting for both recreational use as well as aquatic life use. Sites OBS-06-0002 (17) and OBS-06-0010 (21) failed for both aquatic life use as well as the rest of the sites failed for recreational use. These stream reaches will be placed on the Draft 2018 303(d) list of impaired waters. Additional information regarding the sampling data can be found in Section

2.4 Water Quality Information.

Based on the water quality duration curves and lack of permitted sources, it can be concluded that the majority of sources of *E. coli* in this subwatershed are nonpoint sources. There are approximately 75 miles of streams in the subwatershed. Based on IDEM data collected in 2015 there will be approximately 36 stream miles impaired for *E. coli* and approximately 8 stream miles listed for IBC on the Draft 2018 303(d) list of impaired waters.

To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events indicate contribution due to runoff. The precipitation data was taken from a National Weather Service Co-operative Station Number 154955 located in Louisville, Kentucky.

Figure 23 illustrate water quality standards violations during all flow ranges that occurred during sampling events. Table 26 provides a summary of the Springle Creek subwatershed, including impaired segment AUID, drainage area, sampling sites, land use, NPDES facilities, and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential nonpoint sources that are contributing to elevated *E. coli* concentrations.

To achieve necessary load reductions for *E.coli* impairments, implementation in Springle Creek Subwaterhsed should focus on BMPs that have an impact throughout most flow regimes. These include septic system outreach and education, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, and vegetated filter strips. See Section 6.2 Critical Conditionsand Table 34 for additional information regarding critical conditions and suitable BMP selection for the South Fork Blue River.

Table 26: Summary of Springle Creek Subwatershed Characteristics

Springle Creek (051401040601)	
Drainage Area	32.7 square miles
TMDL Sample Site	OBS-06-0002 (17), OBS-06-0003 (16), OBS-06-0005 (20), OBS-06-0010 (21), OBS-06-0011 (19), OBS-06-0019 (18)
Listed Segments	INN0461_01, INN0461_02, INN0461_03, INN0461_04, INN0461_T1004, INN0461_T1005, INN0461_T1006, INN0461_T1007, INN0461_T1008, INN0461_T1009, INN0461_T1012, INN0461_T1014, INN0461_T1018
Land Use	Agricultural Land: 9.7% Forested Land: 64.78% Developed Land: 3.95% Open Water: 0.28% Pasture/Hay: 20.56% Grassland/Shrubs: 0.83% Wetland: 0.1%
NPDES Facilities	NA
CAFOs	NA
CFOs	Tim & Johnica Branaman (FarmID: 6676)
TMDL *E. coli* Allocations (MPN/day)	

Allocation Category Duration Interval (%)	High Flows 5%	Moist Conditions 25%	Mid-Range Flows 50%	Dry Conditions 75%	Low Flows 95%
TMDL = LA+WLA+MOS	9.50E+11	2.57E+11	9.24E+10	2.33E+10	5.38E+09
LA	8.08E+11	2.19E+11	7.85E+10	1.98E+10	4.58E+09
WLA	NA	NA	NA	NA	NA
MOS (10%)	9.50E+10	2.57E+10	9.24E+09	2.33E+09	5.38E+08
Future Growth (5%)	4.75E+10	1.29E+10	4.62E+09	1.16E+09	2.69E+08

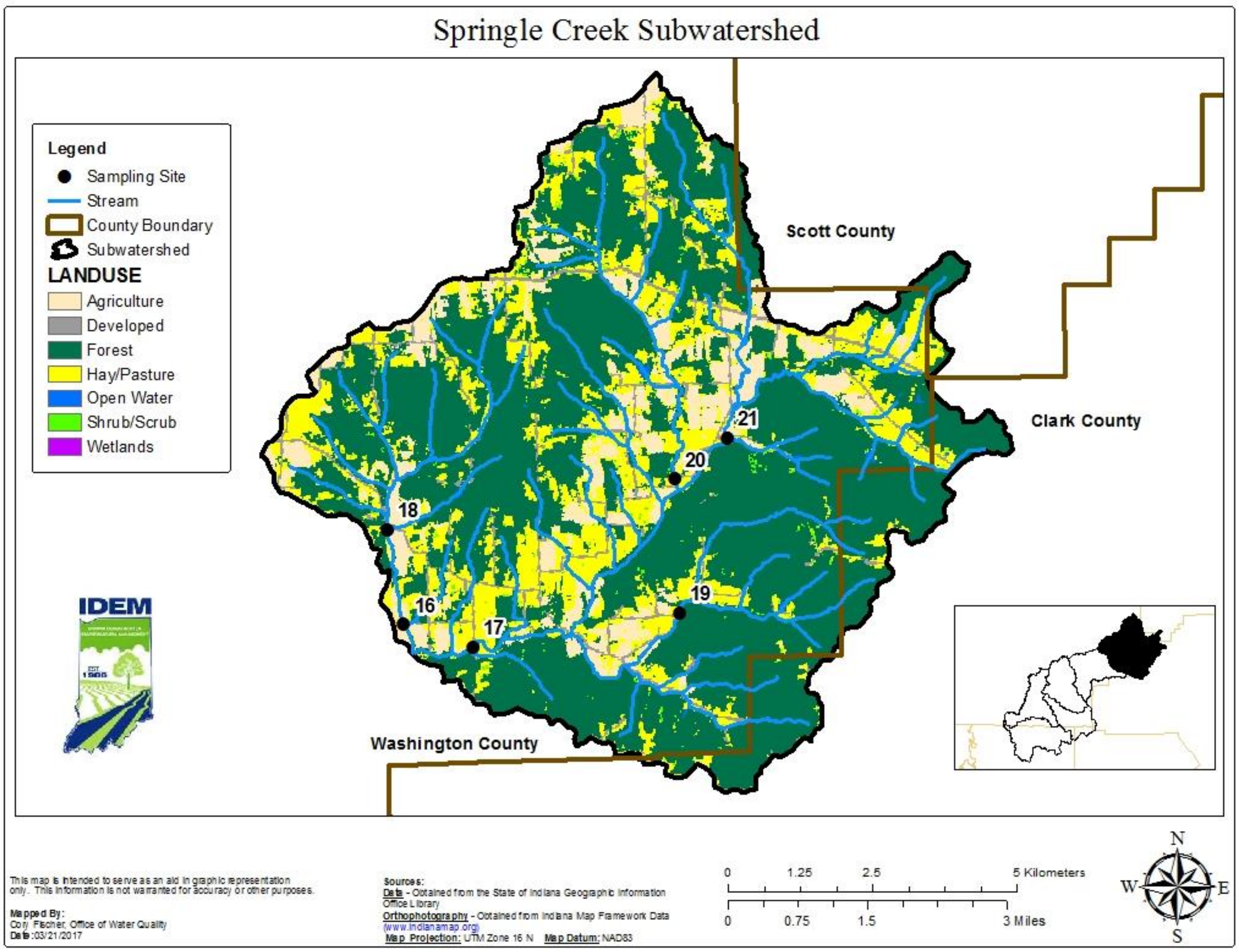

Figure 22: Sampling stations in Springle Creek Watershed

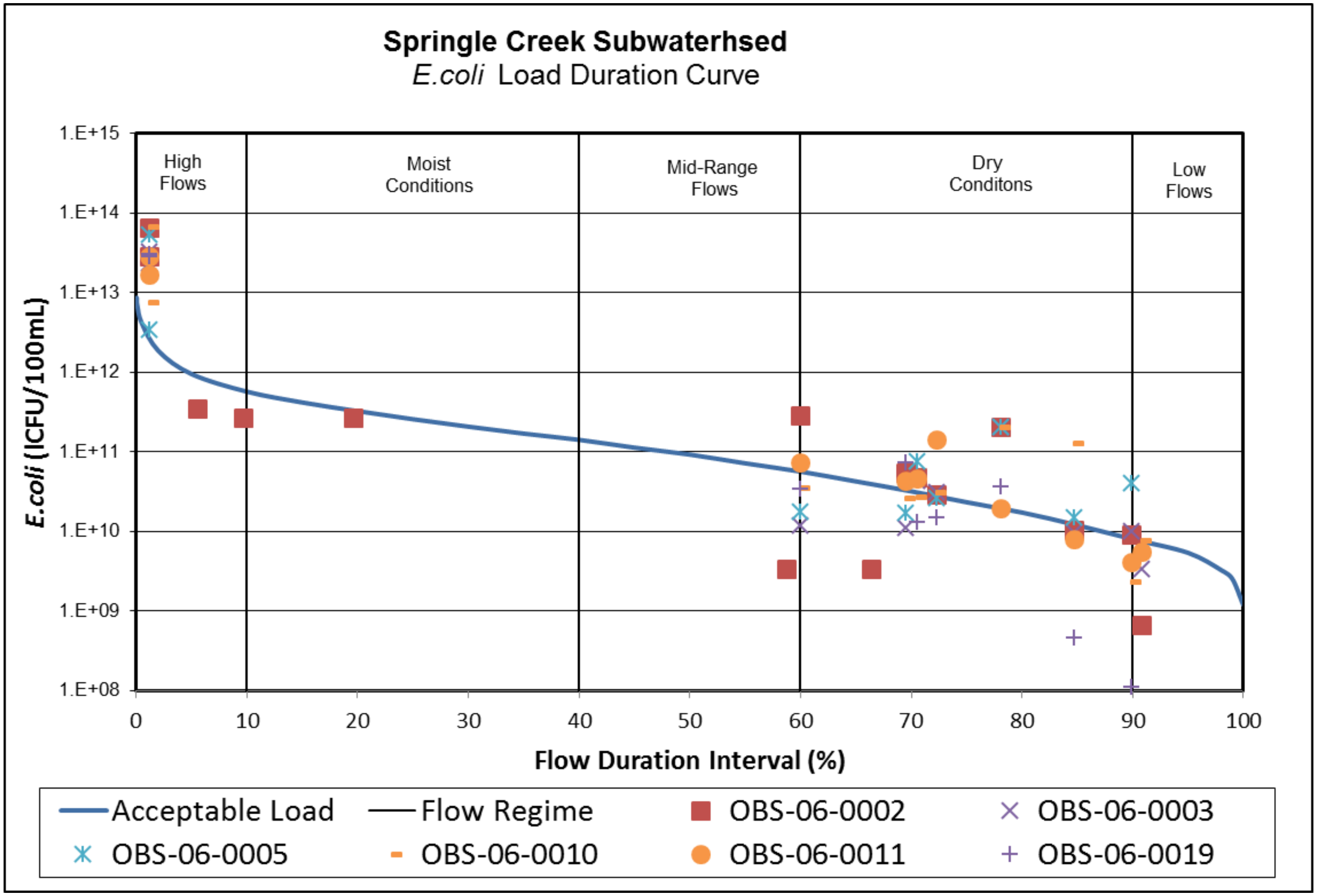

Figure 23: Load Duration Curve for *E. coli* data in the Springle Creek Watershed

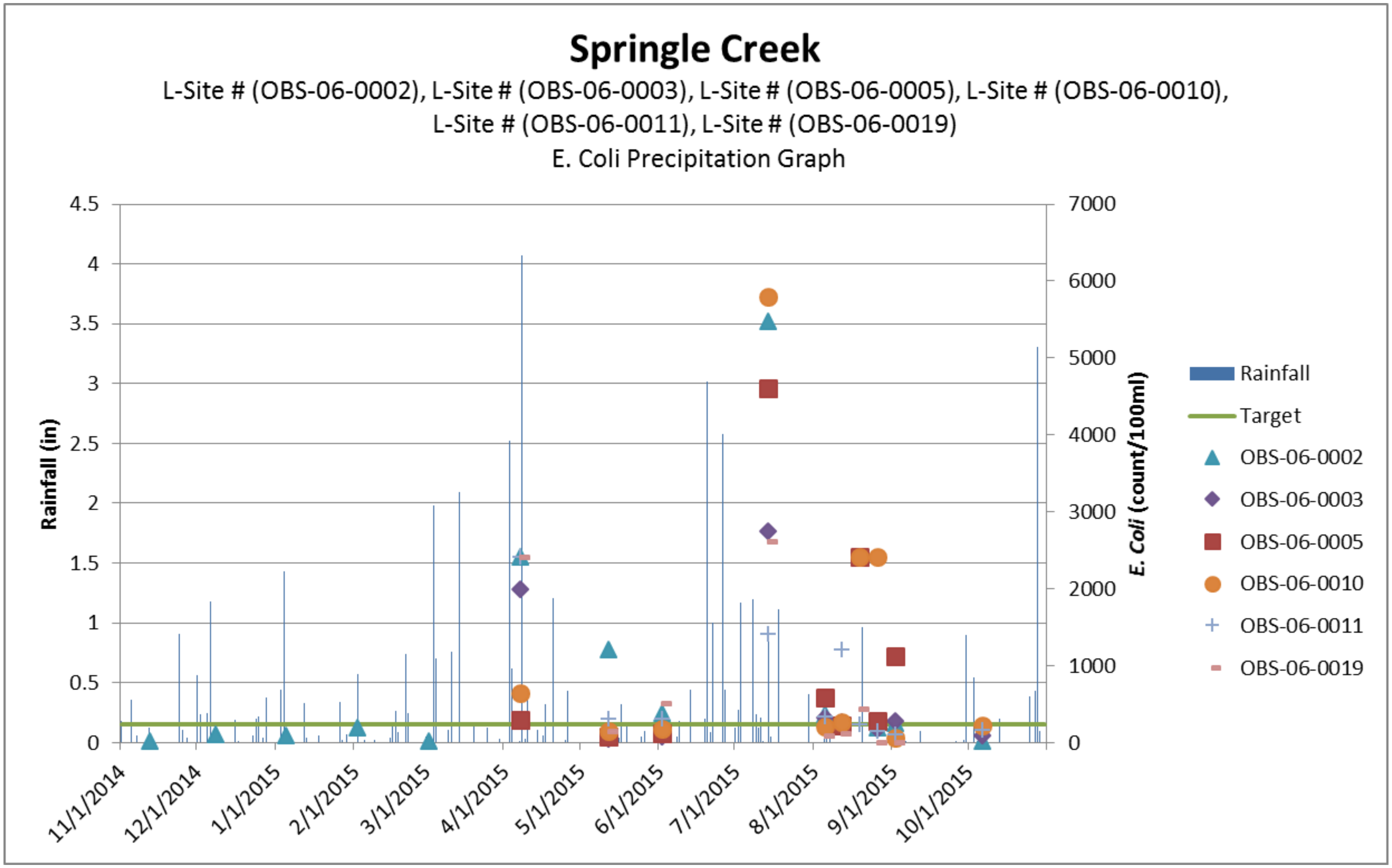

Figure 24: Load Duration Curve for *E. coli* Data in the Springle Creek Watershed

5.2.2 City Of Pekin Subwatershed

The City of Pekin subwatershed drains approximately 52 square miles. The subwatershed drains the uppermost main stem of the South Fork Blue River in the northeast portion of the watershed and continues as it flows through the City of New Pekin. The land use is primarily forested (40%) followed by hay and pasture land (40%) and agricultural (12%). There is one permitted NPDES discharger in the watershed. The New Pekin WWTP (IN0021059) operates a controlled discharge waste stabilization lagoon facility, see Section 3.9.1 Wastewater Treatment Plants (WWTPs)for additional information. The majority of the subwatershed is rural, indicating homes pump to on-site septic systems, other than the City of New Pekin which has an estimated 650 homes. Based on the septic suitability of the soil, this entire subwatershed is very limited. Maintenance and inspections of septic systems in the area are important to ensure proper function and capacity. Due to its geological nature the subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

With land use of approximately 40 percent pasture land, a heavy presence of pasture animals is expected, many of which could have direct access to the stream corridor. There are also four regulated CFO in the subwatershed that may be land applying manure that could contribute to high levels of *E. coli*.

There are four sampling sites located in the City of Pekin Subwatershed, two located on Tributaries of South Fork Blue River OBS-06-0006 (12), OBS-06-0012 (13), and two located on South Fork Blue River OBS-06-0018 (14) and OBS-06-0022 (15). In 2015 this watershed was sampled monthly resulting in all sites failing the WQS for *E. coli*. The watershed had only a slight to moderate impairment with geometric means ranging from 171-467 MPN/100mL. Nine stream reaches will be placed on the 2018 303(d) list of impaired waters. Additional information regarding the sampling data can be found in Section

2.4 Water Quality Information.

Based on the water quality duration curves and one small WWTP in the subwatershed, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources. There are approximately 55 miles of streams in the subwatershed. Based on IDEM data collected in 2015 there will be approximately 21 stream miles impaired for *E. coli* on the Draft 2018 303(d) list of impaired waters.

To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events indicate contribution due to runoff. The precipitation data was taken from a National Weather Service Co-operative Station Number 154955 located in Louisville Kentucky.

The figures illustrate water quality standards violations during all flow ranges that occurred during high flow as well as dry condition sampling events. Table 27 provides a summary of the City of Pekin Subwatershed, including impaired segment AUID, drainage area, sampling sites, land use, NPDES facilities, CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations

To achieve necessary load reductions for *E.coli* impairments, implementation in City of Pekin Subwaterhsed should focus on BMPs that have an impact throughout most flow regimes. These include septic system outreach and education, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, urban storm water management, and vegetated filter strips. Ensuring continued compliance at the New Pekin WWTP will also ensure that point source contributions are minimalized. See Section 6.2 Critical Conditionsand Table 34 for additional information regarding critical conditions and suitable BMP selection for the South Fork Blue River.

Table 27: Summary of City of Pekin Subwatershed Characteristics

City of Pekin (051401040602)					
Drainage Area	32.7 square miles				
TMDL Sample Site	OBS-06-0006(12), OBS-06-0012(13), OBS-06-0018 (14), OBS-06-0022(15),				
Listed Segments	INN0462_01, INN0462_02, INN0462_T1007, INN0462_T1008, INN0462_T1009, INN0462_T1010, INN0462_T1011, INN0462_T1012, INN0462_T1013				
Land Use	Agricultural Land: 11.73% Forested Land: 39.87% Developed Land: 6.52% Open Water: 1.06% Pasture/Hay: 40.08% Grassland/Shrubs: 0.74% Wetland: 0%				
NPDES Facilities	New Pekin WWTP (IN0021059)				
CAFOs	NA				
CFOs	Wright Brothers Farm (FarmID: 840), William Powers (FarmID:4999), Souder Farm (FarmID:6260), Jerald Green (FarmID:6337)				
TMDL *E. coli* Allocations (MPN/day)					
Allocation Category **Duration Interval (%)**	**High Flows** **5%**	**Moist Conditions** **25%**	**Mid-Range Flows** **50%**	**Dry Conditions** **75%**	**Low Flows** **95%**
TMDL = LA+WLA+MOS	1.50E+12	4.07E+11	1.47E+11	3.83E+10	1.01E+10
Upstream Drainage (Springle Creek)	9.50E+11	2.57E+11	9.24E+10	2.33E+10	5.38E+09
LA	3.18E+11	8.69E+10	3.20E+10	8.95E+09	2.99E+09

WLA	1.50E+11	4.07E+10	1.47E+10	3.83E+09	1.01E+09
MOS (10%)	5.50E+10	1.50E+10	5.49E+09	1.50E+09	4.71E+08
Future Growth (5%)	2.75E+10	7.51E+09	2.75E+09	7.52E+08	2.35E+08
WLA Breakdown					
New Pekin WWTP (10% of TMDL)	1.50E+11	4.07E+10	1.47E+10	3.83E+09	1.01E+09

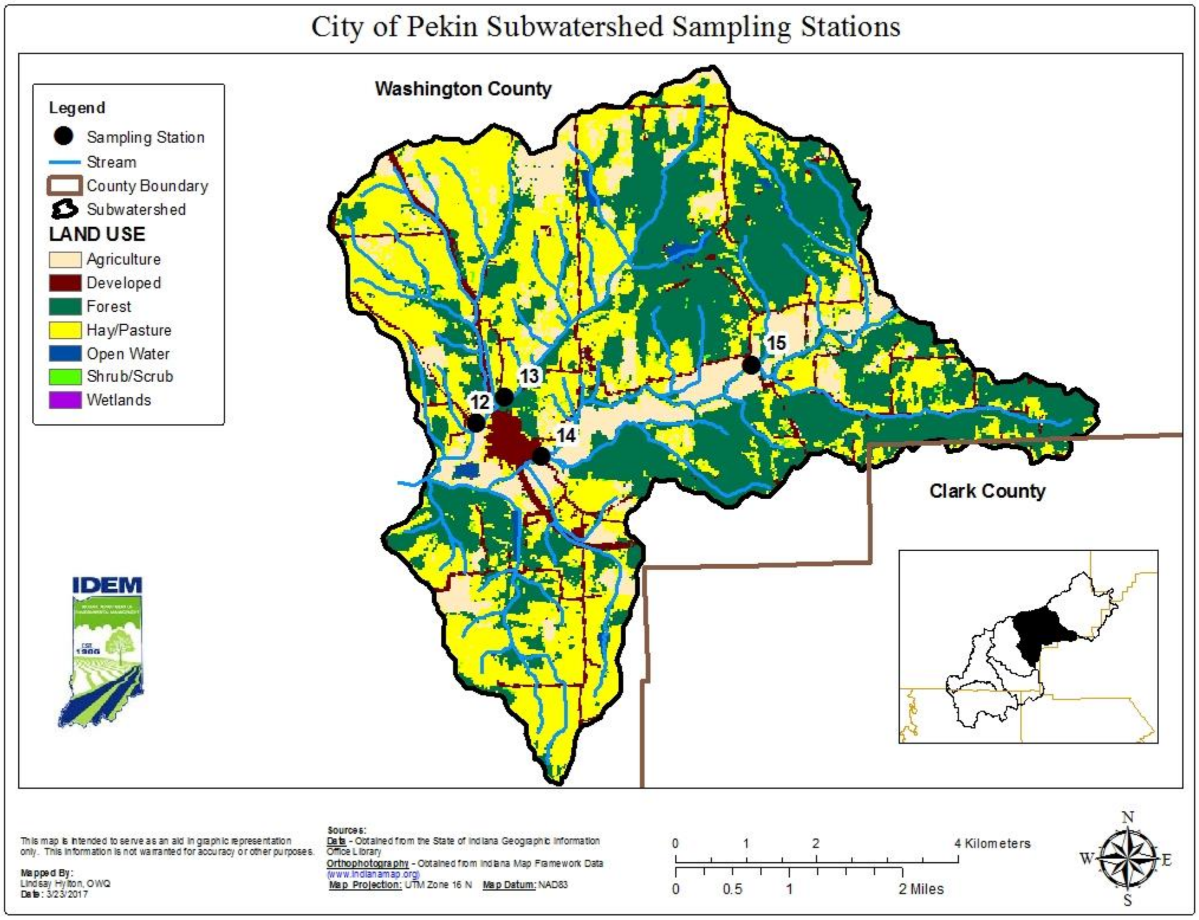

Figure 25: Sampling stations in City of Pekin Subwatershed

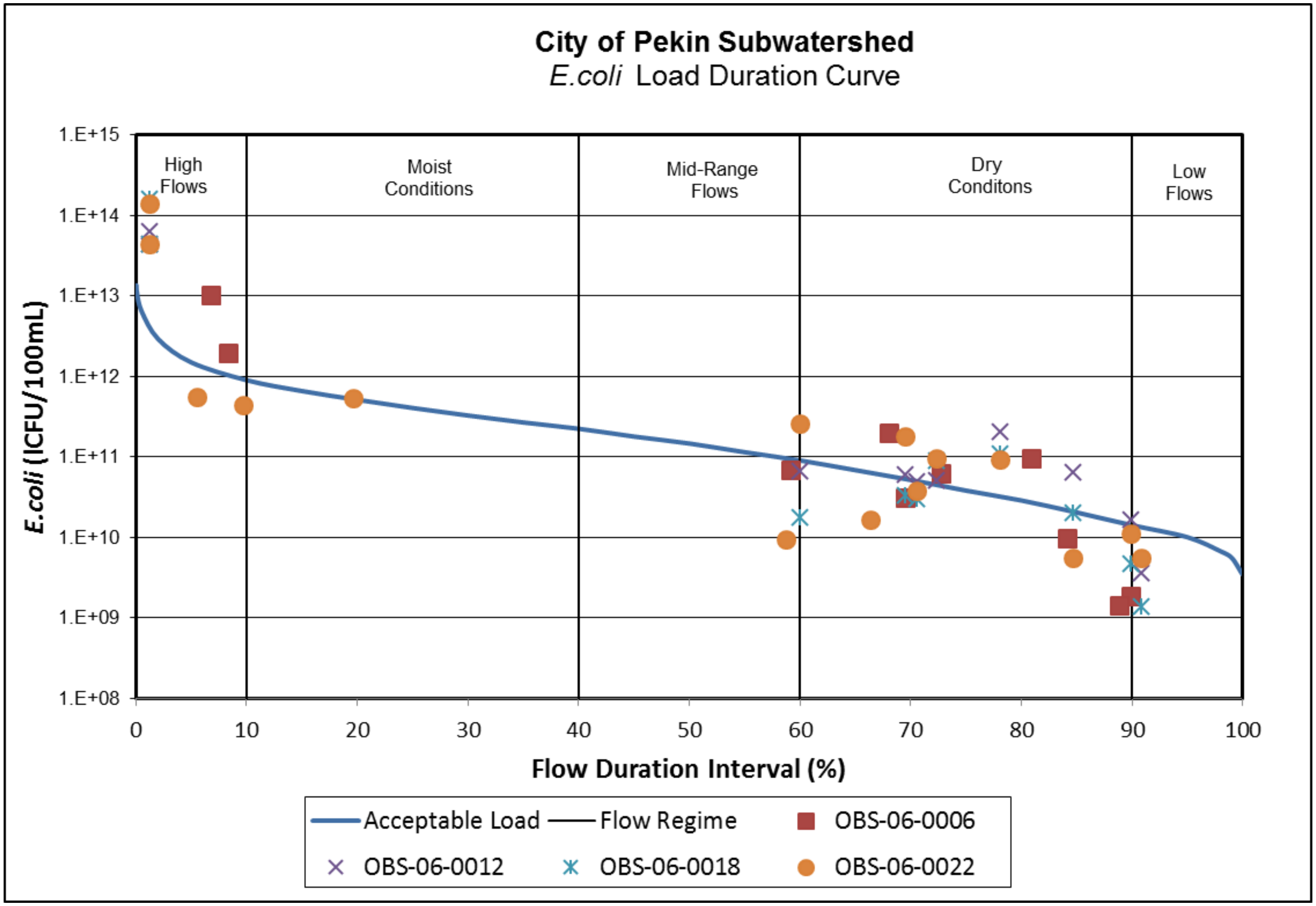

Figure 26: Load Duration Curve for *E. coli* data in the City of Pekin Watershed

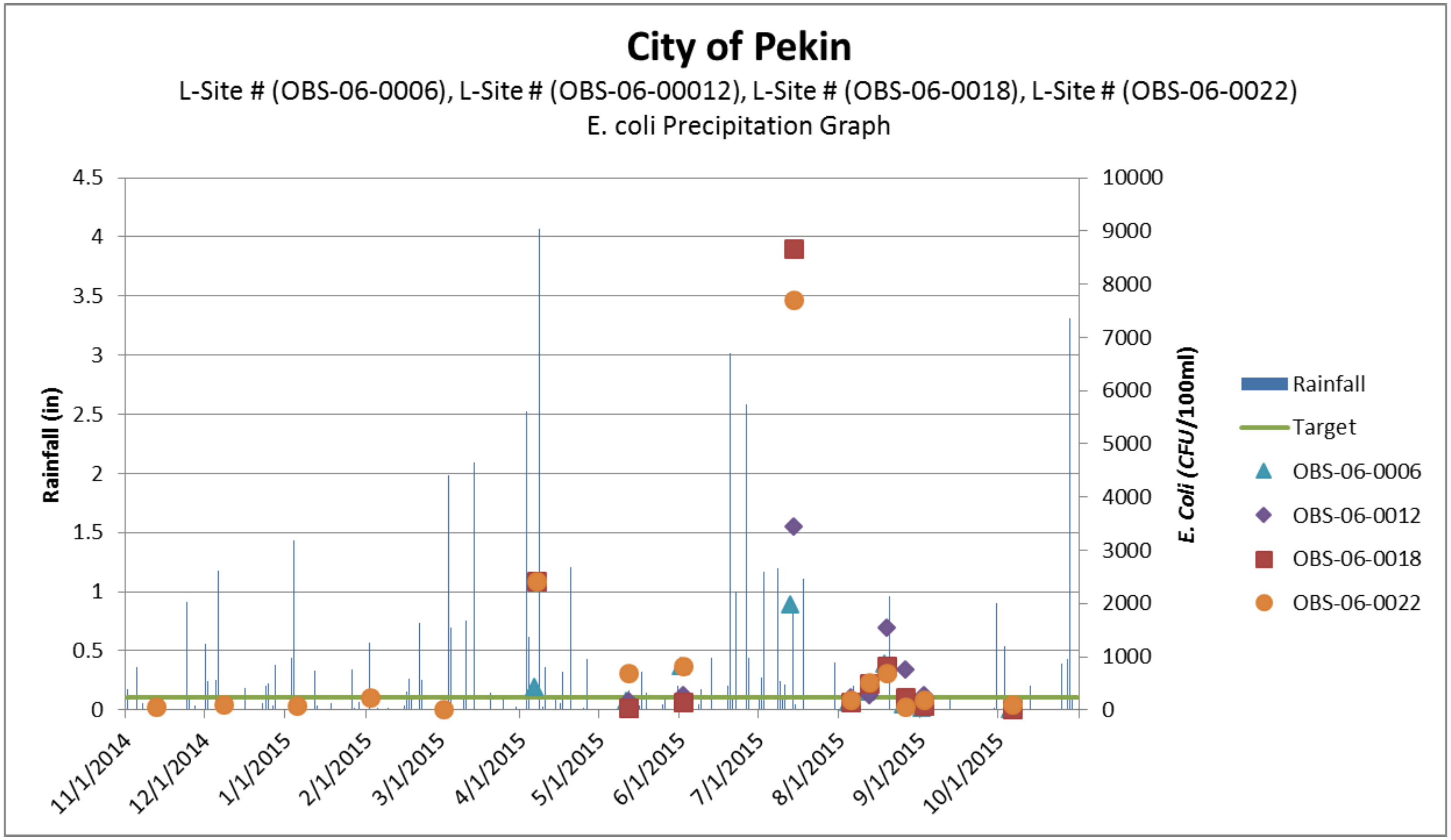

Figure 27: Graph of Precipitation and *E. coli* Data in the City of Pekin Subwatershed

5.2.3 Bear Creek Subwatershed

The Bear Creek subwatershed drains approximately 14 square miles. The land use is primarily forested (45%) followed by hay and pasture land (31%) and agricultural (12%). There are no permitted facilities, WWTPs, or industrial storm water permits in the subwatershed. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. Due to its geological nature the subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

With a land use of approximately 31 percent pasture land a heavy presence of pasture animals is expected, many of which have direct access to the stream corridor.

There are three sampling sites located in the Bear Creek Subwatershed, OBS-06-0013 (6), OBS-06-0014 (5), and OBS-06-0021 (4) are located on Bear Creek. In 2015 this watershed was sampled monthly resulting in all three sites failing the WQS for *E. coli*. The watershed had moderate impairment with geometric means ranging from 350-901 MPN/100mL. Ten stream reaches will be placed on the 2018 303(d) list of impaired waters. Additional information regarding the sampling data can be found in Section

2.4 Water Quality Information.

Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources. There are approximately 29 miles of streams in the subwatershed. Based on IDEM data collected in 2015 there will be approximately 29 stream miles impaired for *E. coli* on the Draft 2018 303(d) list of impaired waters.

To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events indicate contribution due to runoff. The precipitation data was taken from a National Weather Service Co-operative Station Number 154955 located in Louisville Kentucky

The figures illustrate water quality standards violations during flow ranges that occurred during high flow as well as dry condition sampling events. Table 28 provides a summary of the Bear Creek Subwatershed, including impaired segment AUID, drainage area, sampling sites, land use, NPDES facilities, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations

To achieve necessary load reductions for *E.coli* impairments, implementation in Bear Creek Subwaterhsed should focus on BMPs that have an impact throughout most flow regimes. These include septic system outreach and education, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, and vegetated filter strips. See Section 6.2 Critical Conditionsand Table 34 for additional information regarding critical conditions and suitable BMP selection for the South Fork Blue River.

Table 28: Summary of Bear Creek Subwatershed Characteristics

Bear Creek (051401040603)					
Drainage Area	14 square miles				
TMDL Sample Site	OBS-06-0013 (6), OBS-06-0014 (5), OBS-06-0021 (4)				
Listed Segments	INN0463_01, INN0463_02, INN0463_03, INN0463_04, INN0463_T1001, INN0463_T1002A, INN0463_T1003, INN0463_T1004, INN0463_T1005, INN0463_T1006				
Land Use	Agricultural Land: 19.70% Forested Land: 44.48% Developed Land: 4.51% Open Water: 0.08% Pasture/Hay: 30.37% Grassland/Shrubs: 0.86% Wetland: 0%				
NPDES Facilities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (MPN/day)					
Allocation Category **Duration Interval (%)**	**High Flows** **5%**	**Moist Conditions** **25%**	**Mid-Range Flows** **50%**	**Dry Conditions** **75%**	**Low Flows** **95%**
TMDL = LA+WLA+MOS	4.05E+11	1.10E+11	3.94E+10	9.92E+09	2.30E+09
LA	3.44E+11	9.32E+10	3.35E+10	8.43E+09	1.95E+09
WLA	NA	NA	NA	NA	NA

MOS (10%)	4.05E+10	1.10E+10	3.94E+09	9.92E+08	2.30E+08
Future Growth (5%)	2.03E+10	5.48E+09	1.97E+09	4.96E+08	1.15E+08

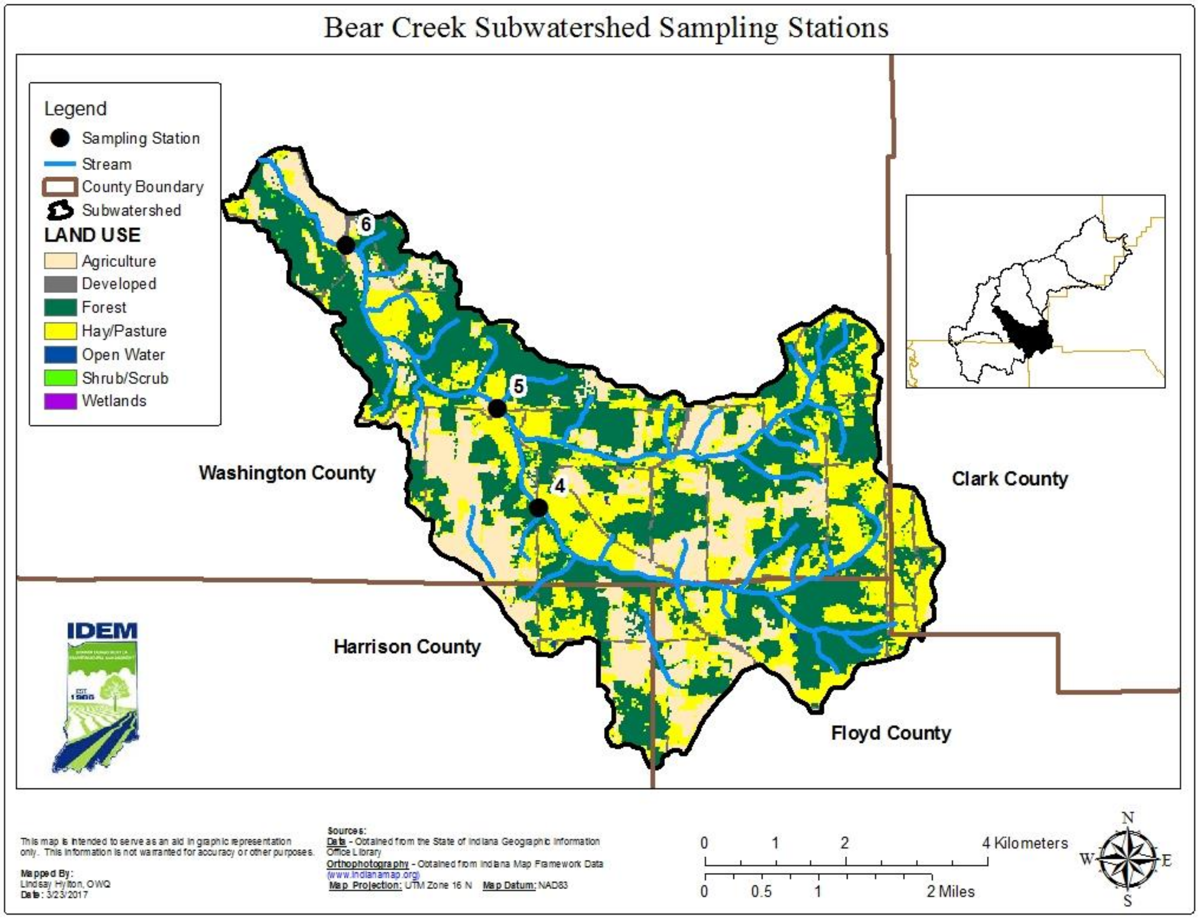

Figure 28: Sampling stations in Bear Creek Subwatershed

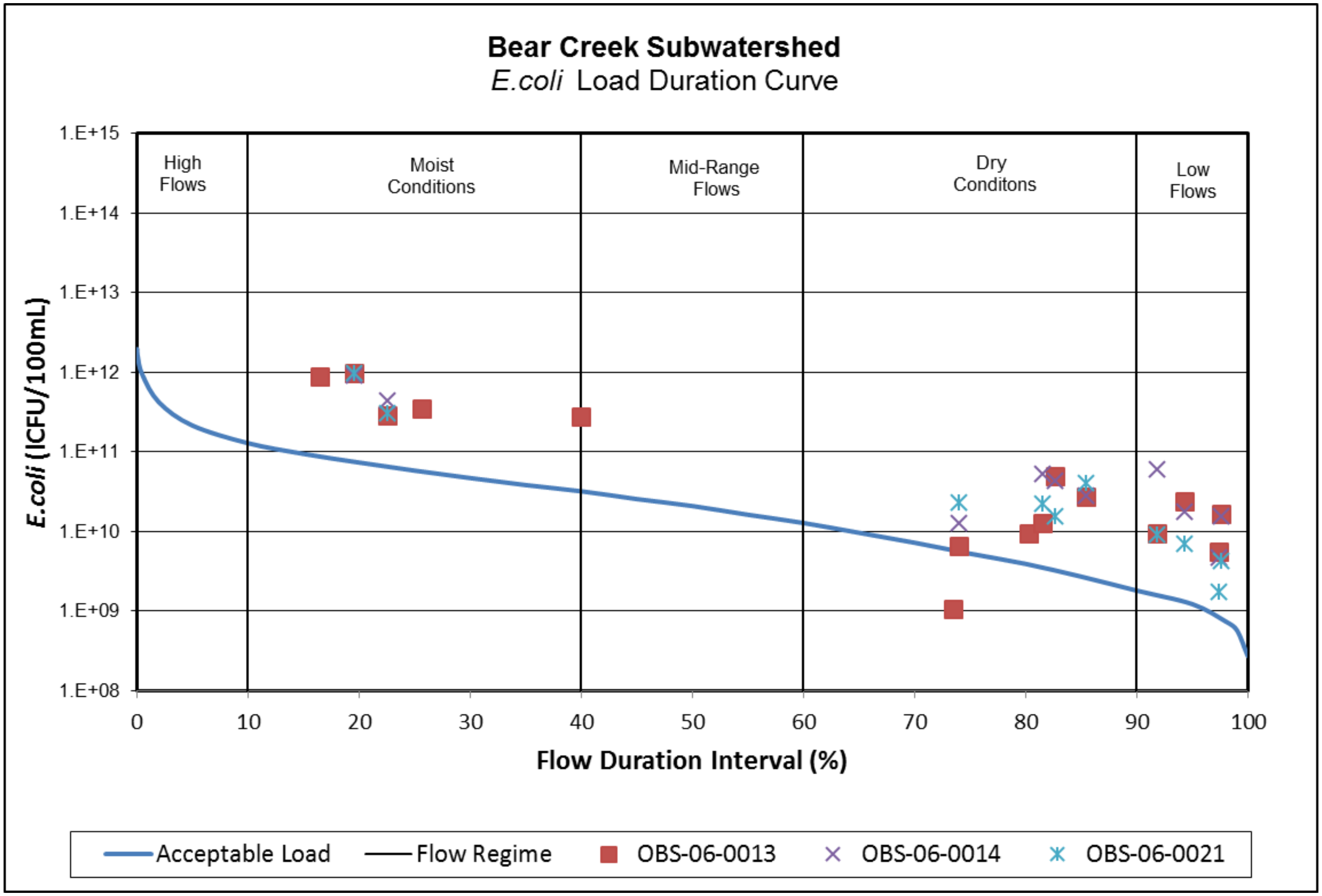

Figure 29: Load Duration Curve for for *E. coli* Data in the Bear Creek Subwatershed

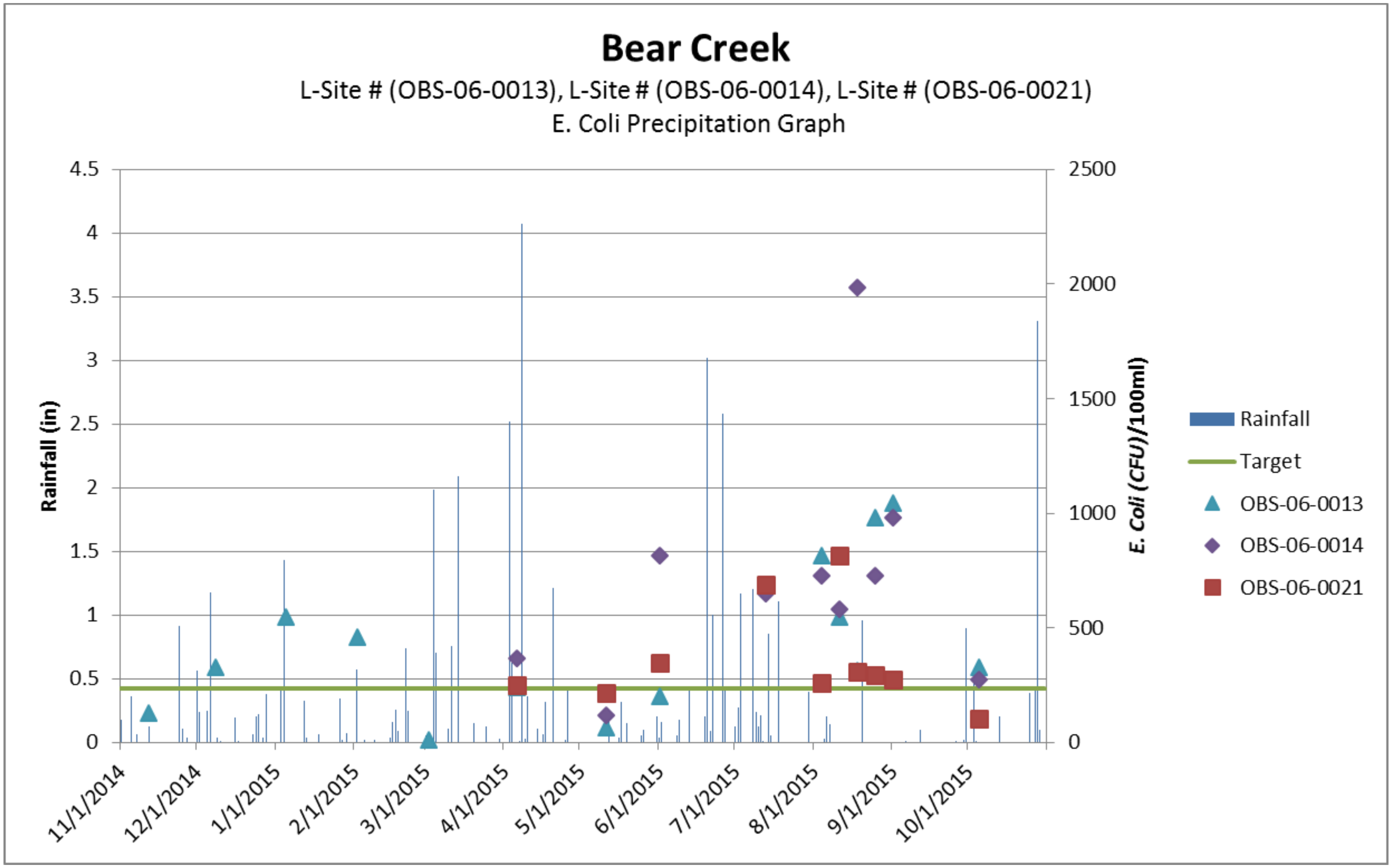

Figure 30: Graph of Precipitation and *E. coli* Data in the Bear Creek Subwatershed

5.2.4 Dutch Creek Subwatershed

The Dutch Creek subwatershed drains approximately 71 square miles. The land use is primarily forested (42%) followed by hay and pasture land (36%) and agricultural (18%). There are no permitted facilities, WWTPs, or industrial storm water permits in the subwatershed. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. Due to its geological nature the subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

With a land use of approximately 36 percent pasture land a heavy presence of pasture animals is expected, many of which could have direct access to the stream corridor.

There are four sampling sites located in the Dutch Creek Subwatershed Site OBS-06-0007 (7) is on Dutch Creek, OBS-06-0009 (10) is located on Punch Run, and OBS-06-0004 (11) and OBS-06-0008 (8) are located on South Fork Blue River. In 2015 this watershed was sampled monthly resulting in three of the four sites failing the WQS for *E. coli*, Site OBS-06-0007 (7) was the only site that didn't exceed the WQS. The watershed had moderate impairment with geometric means ranging from 42-654 MPN/100mL. Nine stream reaches will be placed on the 2018 303(d) list of impaired waters for *E. coli*. Additional information regarding the sampling data can be found in Section

2.4 Water Quality Information.

Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources. There are approximately 51 miles of streams in the subwatershed. Based on IDEM data collected in 2015 there will be approximately 42 stream miles impaired for *E. coli* on the Draft 2018 303(d) list of impaired waters.

To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events indicate contribution due to runoff. The precipitation data was taken from a National Weather Service Co-operative Station Number 154955 located in Louisville Kentucky.

The figures illustrate water quality standards violations during flow ranges that occurred during high flow as well as dry condition sampling events. Table 29 provides a summary of the Dutch Creek Subwatershed, including impaired segment AUID, drainage area, sampling sites, land use, NPDES facilities, CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations

To achieve necessary load reductions for *E.coli* impairments, implementation in Dutch Creek Subwaterhsed should focus on BMPs that have an impact throughout most flow regimes. These include septic system outreach and education, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, and vegetated filter strips. See Section 6.2 Critical Conditionsand Table 34 for additional information regarding critical conditions and suitable BMP selection for the South Fork Blue River.

Table 29: Summary of Dutch Creek Subwatershed Characteristics

Dutch Creek (051401040604)					
Drainage Area	71 square miles				
TMDL Sample Site	OBS-06-0007 (7), OBS-06-0009 (10), OBS-06-0004 (11), OBS-06-0008 (8)				
Listed Segments	INN0464_01, INN0464_02, INN0464_03, INN0464_T1003, INN0464_T1005, INN0464_T1006, INN0464_T1007, INN0464_T1008, INN0464_T1009				
Land Use	Agricultural Land: 17.50% Forested Land: 41.92% Developed Land: 3.87% Open Water: 0.06% Pasture/Hay: 35.88% Grassland/Shrubs: 0.77% Wetland: 0%				
NPDES Facilities	NA				
CAFOs	NA				
CFOs	David Pickerill (FarmID: 193), Gary M Temple (FarmID): 727, Jeffery Pickerill (FarmID: 6554)				
TMDL *E. coli* Allocations (Billion MPN/day)					
Allocation Category **Duration Interval (%)**	**High Flows** **5%**	**Moist Conditions** **25%**	**Mid-Range Flows** **50%**	**Dry Conditions** **75%**	**Low Flows** **95%**
TMDL = LA+WLA+MOS	2.06E+12	5.58E+11	2.00 E+11	5.05E+10	1.17E+10
Upstream Drainage (City of Pekin, Springle Creek subwatersheds)	1.50E+12	4.07E+11	1.47E+11	3.83E+10	1.01E+10
LA	4.77E+11	1.28E+11	4.52E+10	1.04E+10	1.35E+09
WLA	NA	NA	NA	NA	NA
MOS (10%)	5.62E+10	1.51E+10	5.32E+09	1.22E+09	1.59E+08

Future Growth (5%)	2.81E+10	7.54E+09	2.66E+09	6.09E+08	7.95E+07

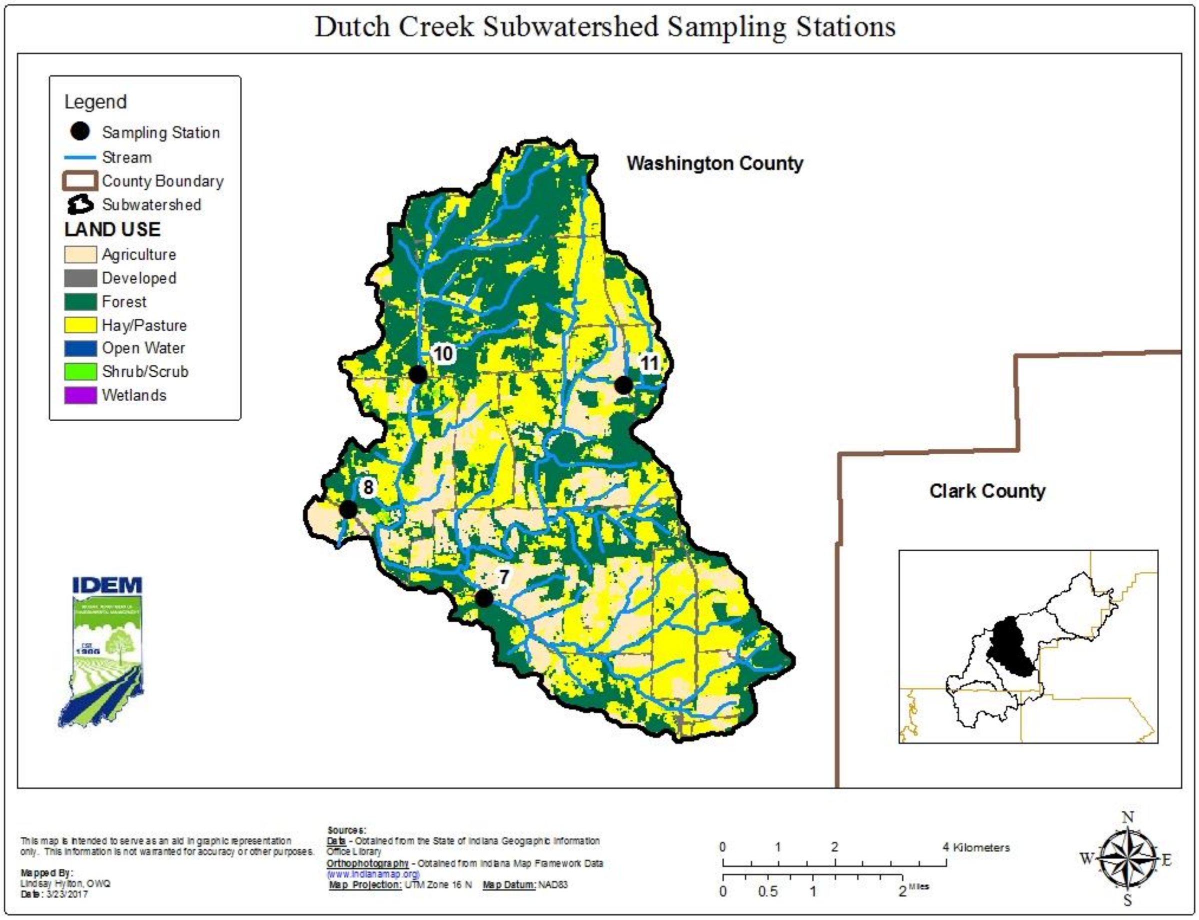

Figure 31: Sampling stations in Dutch Creek Subwatershed

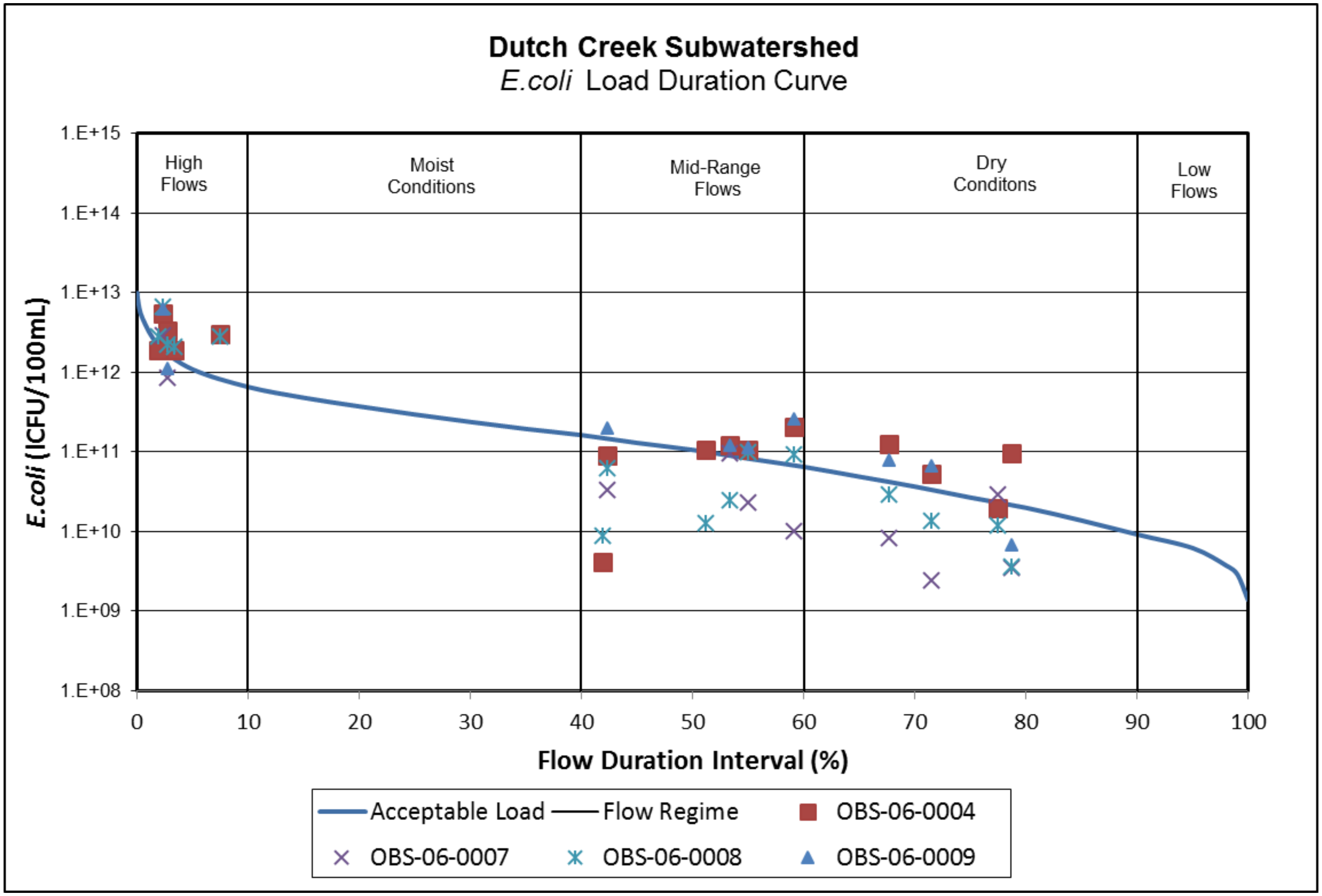

Figure 32: Load Duration Curve for *E. coli* Data in the Dutch Creek Watershed

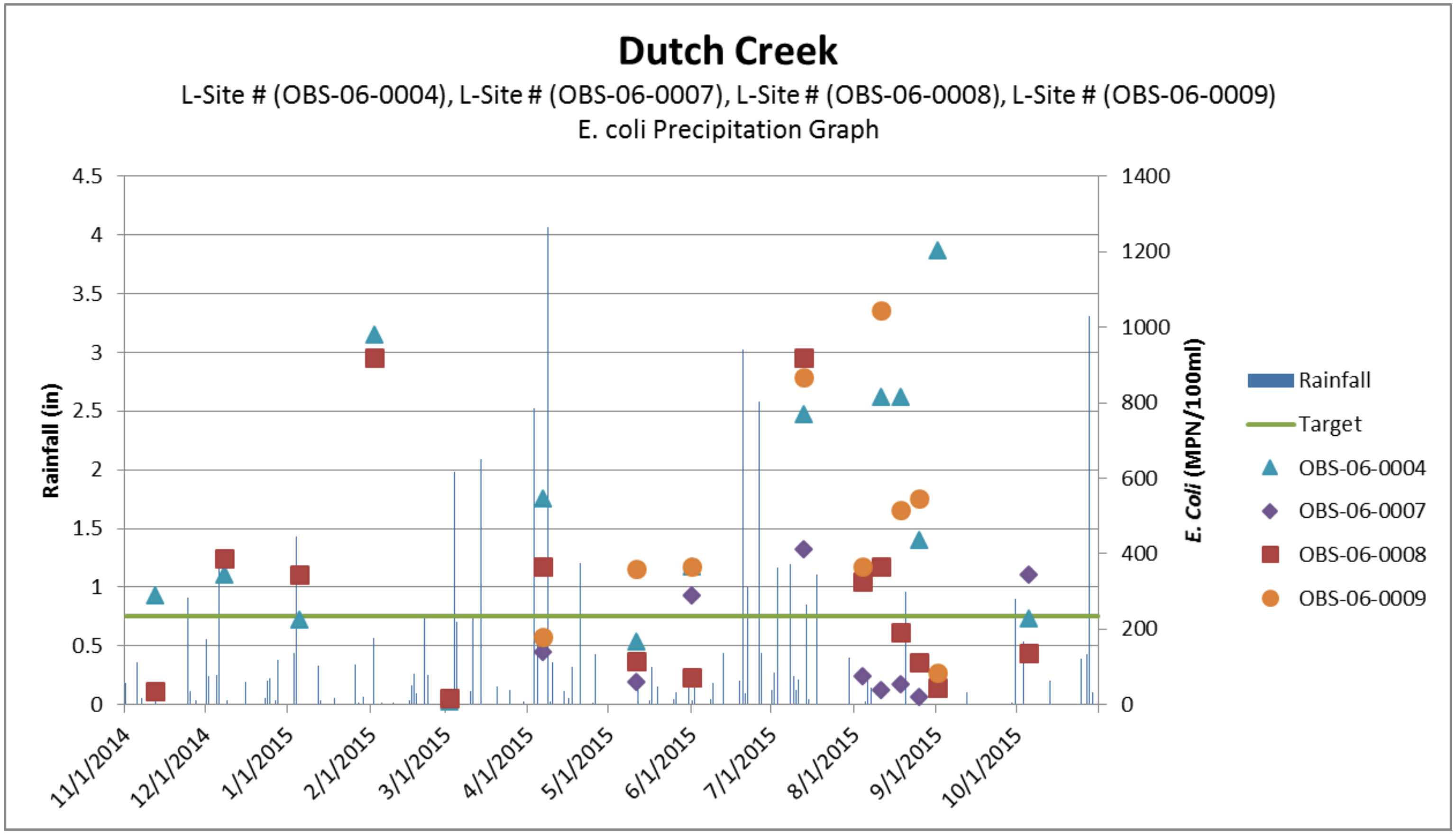

Figure 33: Graph of Precipitation and *E. coli* Data in the Dutch Creek Subwatershed

5.2.5 Licking Creek and Palmyra Karst Area Subwatersheds

The Licking Creek and Palmyra Karst subwatersheds drains approximately 126 square miles. The Palmyra Karst Area subwatershed has been grouped in with the Licking Creek Subwatershed because many of the sinkholes are expected to discharge into the South Fork Blue River within the boundaries of the Licking Creek Subwatershed. The land use is primarily forested (40%) followed by hay and pasture land (28%) and agricultural (27%). There is one permitted NPDES discharger in the watershed. The Town of Palmyra (IN0039403) currently owns and operates a Class I, 0.14 MGD Biolac activated sludge-type treatment facility, see Section 3.9.1 Wastewater Treatment Plants (WWTPs)for additional information. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. There was no stream sampling conducted within the Palmyra Karst Area Subwatershed, however it is noted that nonpoint source contributions from the watershed may be impacting the South Fork Blue River. Also, dye testing from the Town of Palmyra WWTP has traced their discharge to Cedar Spring discharging into South Fork Blue River, therefore the Palmyra WWTP WLA will be assigned to Licking Creek Subwatershed. Due to these uncertainties an additional 10% MOS has been added to the Licking Creek Subwatershed TMDL.

With a land use of approximately 28 percent pasture land a heavy presence of pasture animals is expected, many of which have direct access to the stream corridor. There are also three regulated CFO in the subwatershed that may be land applying manure that could contribute to high levels of *E. coli*.

There are four sampling sites located in the Licking Creek Subwatershed Site OBS-06-0015 (3) is on Licking Creek, OBS-06-0016 (2), OBS130-0002 (1) and OBS-06-0020 (9) are located on South Fork Blue River. In 2015 this watershed was sampled monthly resulting in all four sites failing the WQS for *E. coli*. The watershed had moderate impairment with geometric means ranging from 173-1089 MPN/100mL. Nine stream reaches will be placed on the 2018 303(d) list of impaired waters for *E. coli*. Additional information regarding the sampling data can be found in Section

2.4 Water Quality Information.

Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources. There are approximately 30 miles of streams within both subwatersheds combined. Based on IDEM data collected in 2015 there will be approximately 17 stream miles impaired for *E. coli* on the Draft 2018 303(d) list of impaired waters.

To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events indicate contribution due to runoff. The precipitation data was taken from National Weather Service Co-operative Station Number 154955 located in Louisville Kentucky.

The figures illustrate water quality standards violations during flow ranges that occurred during high flow as well as dry condition sampling events.
Table 30 provides a systems, runoff from agricultural areas, and bacterial re-suspension from the streambed. *E. coli* sources typically associated with low flow conditions include a large number of homes on failing or illicitly connected septic systems that would provide a constant source. Elevated *E. coli* levels at low flow could also result from inadequate disinfection at wastewater treatment plants or animals with direct access to streams. Summary of the Licking Creek Subwatershed, including impaired segment AUID, drainage area, sampling sites, land use, NPDES facilities, CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations

To achieve necessary load reductions for *E.coli* impairments, implementation in Licking Creek and Palmyra Karst Area Subwaterhseds should focus on BMPs that have an impact throughout most flow regimes. These include septic system outreach and education, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, and vegetated filter strips. Outreach and education on how karst topography can impact surface water may also help achieve pollutant load reductions. See Section 6.2 Critical Conditionsand Table 34 for additional information regarding critical conditions and suitable BMP selection for the South Fork Blue River.

Table 30: Summary of Licking Creek Subwatershed Characteristics

Licking Creek (051401040606)					
Drainage Area	126 square miles				
TMDL Sample Site	OBS-06-0015 (3),OBS-06-0016 (2), OBS130-0002 (1), OBS-06-0020 (9)				
Listed Segments	INN0466_01, INN0466_02, INN0466_03, INN0466_04, INN0466_05, INN0466_06, INN0466_07, INN0466_08, INN0466_T1004				
Land Use	Agricultural Land: 26.86% Forested Land: 39.87% Developed Land: 4.19% Open Water: 0.16% Pasture/Hay: 28.03% Grassland/Shrubs: 0.89% Wetland: 0%				
NPDES Facilities	Palmyra WWTP (IN0039403)				
CAFOs	NA				
CFOs	Cory Beach (FarmID: 2833), Purlee and Purlee Farms (FarmID: 3488) Glenn Beach (FarmID:4165)				
TMDL *E. coli* Allocations (MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**“Normal” Flows**	**Lower Flow Conditions**	**Low Flows**

TMDL = LA+WLA+MOS	**3.66E+12**	**9.91E+11**	**3.56E+11**	**8.96E+10**	**2.07E+10**
Upstream Drainage (City of Pekin, Springle Creek, Bear Creek, Dutch Creek, Palmyra Karst subwatersheds)	2.47E+12	6.68E+11	2.40E+11	6.04E+10	1.40E+10
LA	8.94E+11	2.41E+11	8.58E+10	2.07E+10	3.83E+09
WLA	1.25E+09	1.25E+09	1.25E+09	1.25E+09	1.25E+09
MOS (20%)	2.39E+11	6.46E+10	2.32E+10	5.84E+09	1.35E+09
Future Growth (5%)	5.97E+10	1.62E+10	5.80E+09	1.46E+09	3.38E+08
WLA Breakdown					
Palmyra WWTP	1.25E+09	1.25E+09	1.25E+09	1.25E+09	1.25E+09

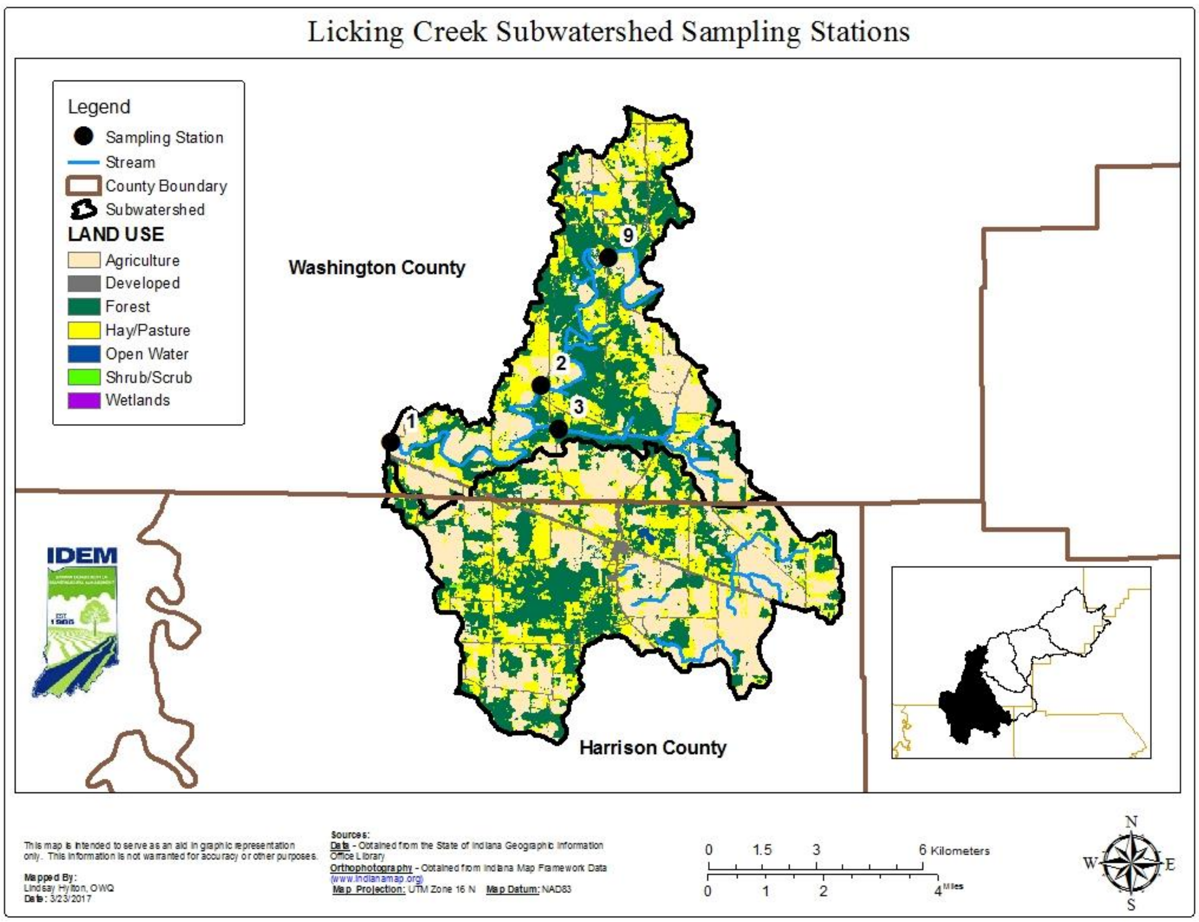

Figure 34: Sampling stations in Licking Creek Watershed

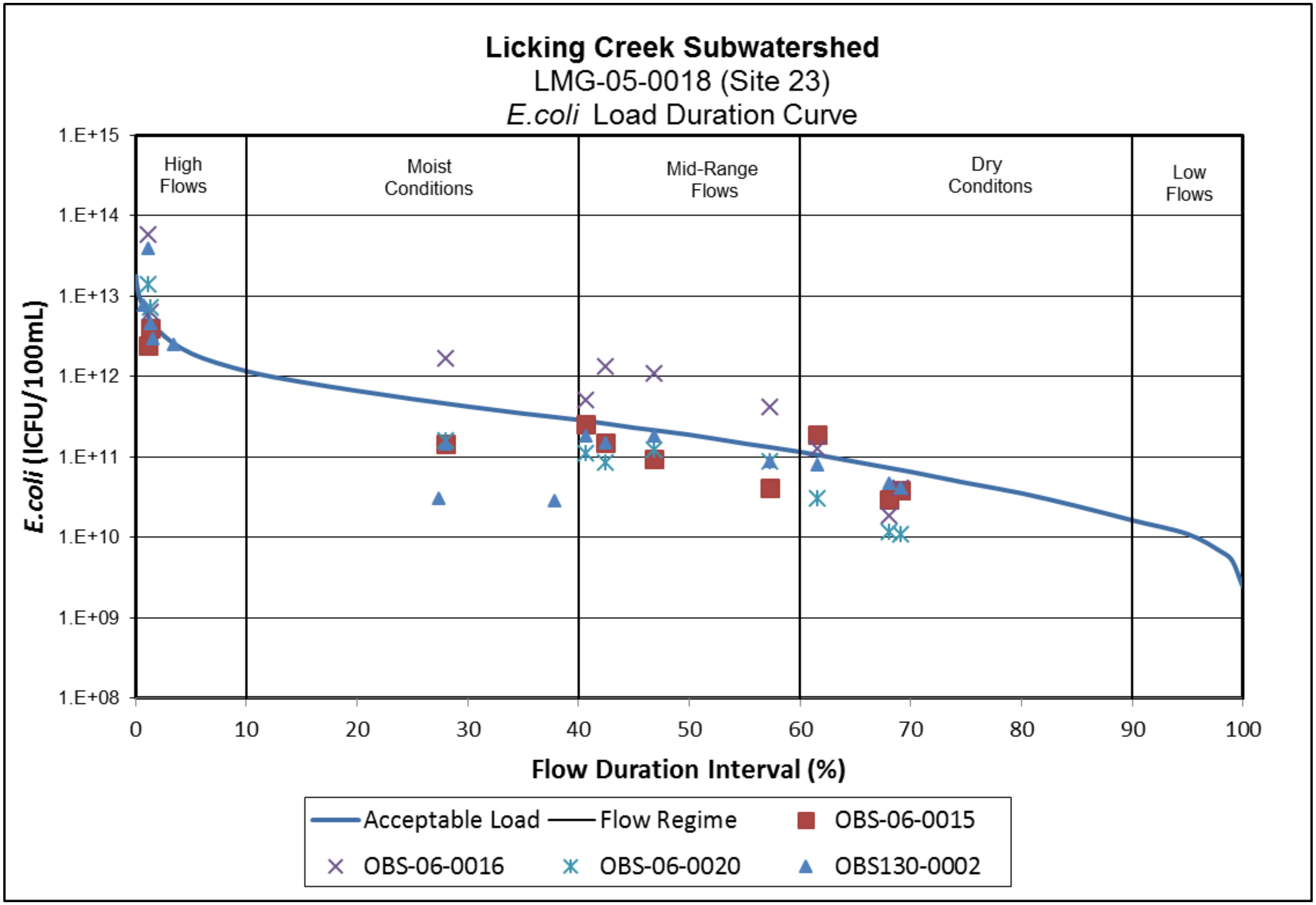

Figure 35: Load Duration Curve for *E. coli* Data in the Licking Creek Watershed

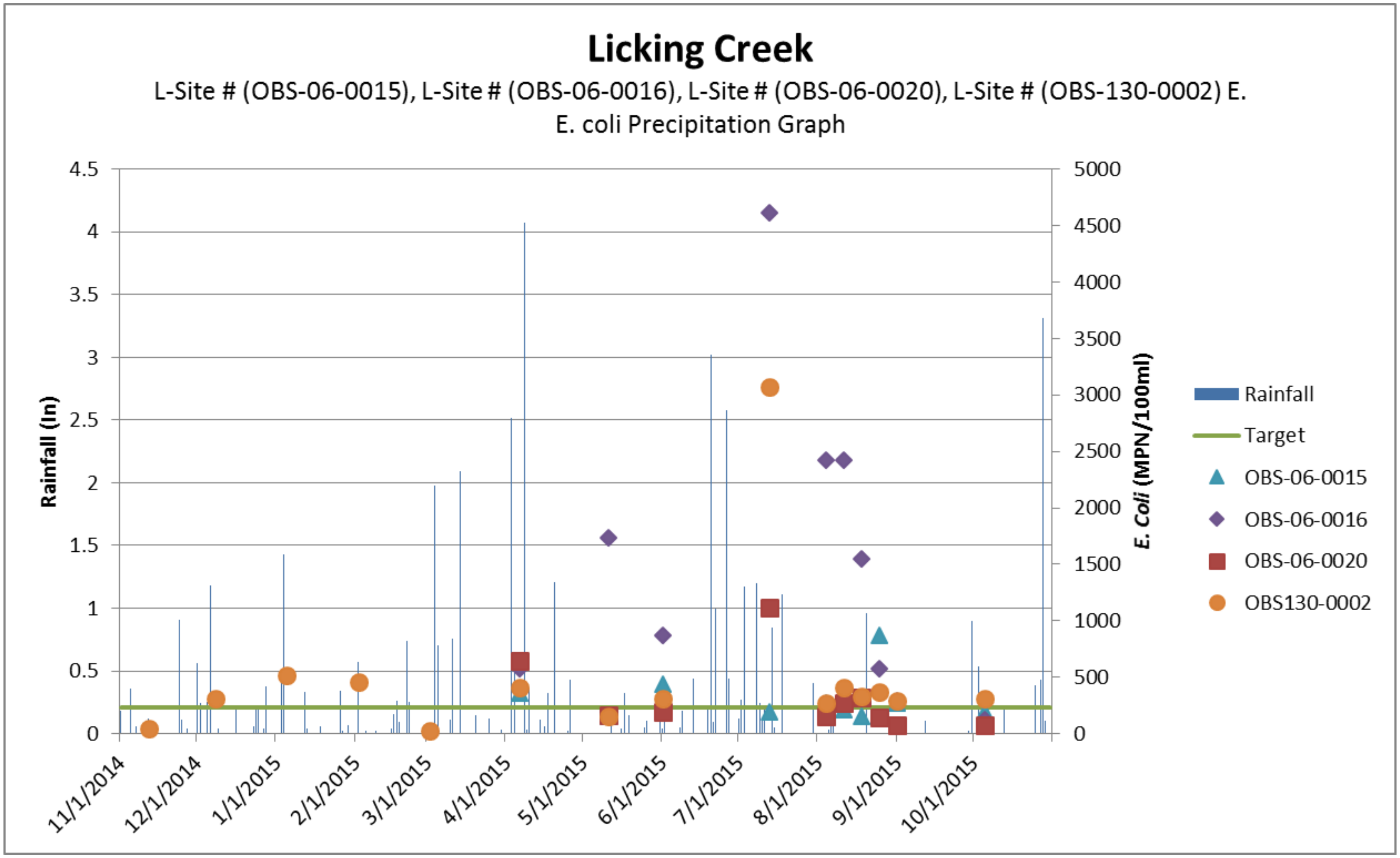

Figure 36: Graph of Precipitation and *E. coli* Data in the Licking Creek Subwatershed

6.0 Allocations

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs are composed of the sum of individual WLAs for regulated point sources and LAs for nonpoint sources not directly regulated by a permit. In addition, the TMDL must include a MOS, either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

6.1 Individual WLAs for NPDES Facilities

The following sections present the allowable pollutant loads and associated allocations for each of the subwatersheds and associated assessment units in the South Fork Blue River Watershed. Allocations were calculated for each permitted facility. Neither WWTP is currently discharging into an IBC or nutrient impaired segment, so phosphorus limits are not being calculated at this time. The Palmyra WLA was calculated based on the design flow of the facility and the TMDL Target. The New Pekin WLA was assigned pursuant to 327 IAC 5-10-3(a) municipal wastewater treatment facilities with multiple cell waste stabilization ponds operating as controlled discharges may discharge at any time provided effluent limits and all conditions of the permit are met and the daily discharge flow rate does not exceed one-tenth (1/10) of the steam flow of the receiving stream. Table 31 presents the individual WLAs for NPDES facilities in the South Fork Blue River watershed by subwatershed.

Table 31: Individual WLAs for NPDES Facilities in the South Fork Blue River Watershed

Subwatershed	AUID	Facility Name	Permit ID	Design Flow (MGD)	*E. coli* WLA (count/day)
Palmyra Karst Area	NA	Palmyra WWTP	IN0039403	0.14	1.25E+09
City Of Pekin	INN0462_T1013	New Pekin WWTP	IN0021059	(1/10) Stream Flow	10% of TMDL (2.51E+08-2.963E+10)

6.2 Critical Conditions

The Clean Water Act requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. The load duration curve approach helps to identify the sources contributing to the impairment and to roughly differentiate between sources. Exceedances of the load duration curve at higher flows (0-40 percent ranges) are indicative of wet weather sources (e.g., nonpoint sources, regulated storm water discharges). Exceedances of the load duration curve at lower flows (60 to 100 percent range) are indicative of point source sources (e.g., wastewater treatment facilities, livestock in the stream). Table 32 summarizes the general relationship between the five hydrologic zones and potentially contributing source areas (the table is not specific to any individual pollutant). Existing loading is calculated as the 90th percentile of measured *E. coli* concentrations under each hydrologic condition class multiplied by the flow at the middle of the flow exceedance percentile. For example, in calculating the existing loading under dry conditions (flow exceedance percentile = 60-90 percent), the 75th percentile exceedance flow is multiplied by the 90th percentile of *E. coli* concentrations measured under 60-90th percentile flows. Table 32 indicates that impacts from wastewater treatment plants are usually most pronounced during dry and low flow zones because there is less water in the stream to dilute their loads. In contrast, impacts from channel bank erosion is most pronounced during high flow zones because these are the periods during which stream velocities are high enough to cause erosion to occur. Through the load duration curve approach it has been determined that load reductions for the parameters of concern are needed for specific flow conditions; the critical conditions (the periods when the greatest reductions are required) vary by location and are summarized in Table 32: Relationship between Load Duration Curve Zones and Contributing Sources

Contributing Source Area	Duration Curve Zone				
	High (0%-10%)	Moist (10%-40%)	Mid-Range (40%-60%)	Dry (60%-90%)	Low (90%-100%)
Wastewater treatment plants			L	M	H
Livestock direct access to streams			L	M	H
Wildlife direct access to streams			L	M	H
Pasture Management	H	H	M		
On-site wastewater systems/Unsewered Areas	L	M	H	H	H
Riparian Buffer areas	H	H	M	M	
Abandoned mines	H	H	H	H	H
Storm water: Impervious	H	H	H		
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M	L	
Bank erosion	H	M	L		

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)
Modified from (EPA, 2007 An Approach for Using Load Duration Curves in the Development of TMDLs)

Table 33. After existing loading and percent reductions are calculated under each hydrologic condition class, the critical condition for each TMDL is identified as the flow condition requiring the largest percent reduction. The table indicates that critical conditions for *E. coli* for most locations occur during the high

flow, and dry flow regimes and therefore implementation of controls should be targeted for these conditions.

Table 32: Relationship between Load Duration Curve Zones and Contributing Sources

Contributing Source Area	Duration Curve Zone				
	High (0%-10%)	Moist (10%-40%)	Mid-Range (40%-60%)	Dry (60%-90%)	Low (90%-100%)
Wastewater treatment plants			L	M	H
Livestock direct access to streams			L	M	H
Wildlife direct access to streams			L	M	H
Pasture Management	H	H	M		
On-site wastewater systems/Unsewered Areas	L	M	H	H	H
Riparian Buffer areas	H	H	M	M	
Abandoned mines	H	H	H	H	H
Storm water: Impervious	H	H	H		
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M	L	
Bank erosion	H	M	L		

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)
Modified from (EPA, 2007 An Approach for Using Load Duration Curves in the Development of TMDLs)

Table 33: Critical Conditions for TMDL Parameters

Parameter	Subwatershed (HUC)	Critical Condition				
		High (0%-10%)	Moist (10%-40%)	Mid-Range (40%-60%)	Dry (60%-90%)	Low (90%-100%)
E. coli	Springle Creek (051401040601)	95%	NA	65%	90%	NA
	City of Pekin (051401040602)	97%	1%	51%	71%	NA
	Bear Creek (051401040603)	66%	49%	52%	77%	--
	Dutch Creek (051401040604)	73%	76%	11%	71%	--
	Palmyra Karst Area (051401040605)	--	--	--	--	--
	Licking Creek (051401040606)	93%	49%	79%	77%	--

Note: **--** = No Data Collected in Flow Regime NA= No reduction needed

The information in Table 32: Relationship between Load Duration Curve Zones and Contributing Sources

Contributing Source Area	Duration Curve Zone				
	High (0%-10%)	Moist (10%-40%)	Mid-Range (40%-60%)	Dry (60%-90%)	Low (90%-100%)
Wastewater treatment plants			L	M	H
Livestock direct access to streams			L	M	H

Wildlife direct access to streams			L	M	H
Pasture Management	H	H	M		
On-site wastewater systems/Unsewered Areas	L	M	H	H	H
Riparian Buffer areas	H	H	M	M	
Abandoned mines	H	H	H	H	H
Storm water: Impervious	H	H	H		
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M	L	
Bank erosion	H	M	L		

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)
Modified from (EPA, 2007 An Approach for Using Load Duration Curves in the Development of TMDLs)

Table 33 and Table 32 provide the foundation necessary to identify subwatersheds that are in need of the most significant pollutant reductions to achieve water quality standards in the South Fork Blue River watershed. Using these two tables along with the Linkage Analysis in Section 5.0 Linkage Analysis, watershed organizations will gain a better understanding of which subwatersheds require the most pollutant load reductions. This can assist in future efforts to identify critical areas in the South Fork Blue River watershed for implementation. The tables above focus on the information and data collected and analyzed through the TMDL development process for percent reduction purposes, whereas critical areas take into account other factors into consideration (e.g., political, social, economic) to help determine implementation feasibility that will affect progress toward pollutant load reductions and, ultimately, attainment of water quality standards. This information can be key to watershed organizations in the process of identifying and selecting critical areas and implementation activities for the purposes of watershed management plan development. IDEM recommends that watershed organizations take the percent reductions into consideration when selecting critical areas for purposes of watershed management planning.

7.0 Reasonable Assurances/Implementation

This section of the South Fork Blue River watershed TMDL focuses on implementation activities that have the potential to achieve the WLAs and LAs presented in Section 5.0 Linkage Analysis. The focus of this section is to identify and select the most appropriate structural and non-structural best management practices (BMPs) and control technologies to reduce *E. coli* loads from sources throughout the South Fork Blue River watershed. This section also addresses the programs that are available to facilitate implementation of structural and non-structural BMPs to achieve the allocations, as well as current ongoing activities in the South Fork Blue River watershed at the local level that will play a key role in successful TMDL implementation.

To select appropriate BMPs and control technologies, it is important to review the significant sources in the South Fork Blue River watershed.

Point Sources

- WWTPs
- Illicitly connected straight pipe systems

Nonpoint Sources

- Cropland
- Hay and Pastureland and unregulated livestock operations
- Confined Feeding Operations and Animal Feeding Operations
- Streambank erosion
- Onsite wastewater treatment systems
- Wildlife/domestic pets
- Urban nonpoint source runoff

7.1 Implementation Activity Options for Sources in the South Fork Blue River Watershed

Keeping the list of significant sources in the South Fork Blue River watershed in mind, it is possible to review the types of BMPs that are most appropriate for the listed impairment and the source type. Table 34 provides a list of implementation activities that are potentially suitable for the South Fork Blue River watershed based on the listed impairments and the types of sources. The implementation activities are a combination of structural and non-structural BMPs to achieve the assigned WLAs and LAs. IDEM recognizes that actions taken in any individual subwatershed may depend on a number of factors (including socioeconomic, political and ecological factors). The recommendations in Table 34 are not intended to be prescriptive. Any number or combination of implementation activities might contribute to water quality improvement, whether applied at sites where the actual impairment was noted or other locations where sources contribute indirectly to the water quality impairment.

Table 34: List of Potentially Suitable BMPs for the South Fork Blue River Watershed

	Pollutant	Point Sources		Nonpoint Sources						
Implementation Activities	**Bacteria**	**WWTPs and Industrial Facilities**	**Illicitly Connected “Straight Pipes”**	**Cropland**	**Pastures and Livestock Operations**	**CFOs**	**Streambank Erosion**	**Onsite Wastewater Treatment Systems**	**Wildlife/Domestic Pets**	**Urban NPS Runoff**
Inspection and maintenance	X	X						X		
Outreach and education and training	X	X	X	X	X	X	X	X	X	X

Implementation Activities	Pollutant	Point Sources		Nonpoint Sources						
	Bacteria	WWTPs and Industrial Facilities	Illicitly Connected “Straight Pipes”	Cropland	Pastures and Livestock Operations	CFOs	Streambank Erosion	Onsite Wastewater Treatment Systems	Wildlife/Domestic Pets	Urban NPS Runoff
System replacement	X		X					X		
Conservation tillage/residue management	X			X						
Cover crops	X			X			X			
Filter strips	X			X	X	X	X			
Grassed waterways	X			X		X	X			X
Riparian forested/herbaceous buffers	X			X	X	X	X		X	
Manure handling, storage, treatment, and disposal	X				X	X				
Composting	X				X	X				
Alternative watering systems	X				X		X			
Stream fencing (animal exclusion)	X				X		X			
Prescribed grazing	X				X		X			
Conservation easements	X						X		X	X
Rain barrel	X									X
Rain garden	X									X
Street rain garden	X									X
Porous pavement	X									X
Green alley	X									X
Green roof	X									X
Storm water planning and management	X	X					X		X	X
Comprehensive Nutrient Management Plan	X			X	X	X				
Constructed Wetland	X	X	X	X					X	X
Heavy Use Area Pad	X				X					
Nutrient Management Plan	X			X	X	X				
Pasture and Hay Planting	X			X	X	X	X		X	
Field Border	X			X	X	X			X	
Waste Treatment Lagoon	X				X	X				

7.2 Implementation Goals and Indicators

For each impairment in the South Fork Blue River watershed, IDEM has identified broad goal statements and indicators. This information is to help watershed stakeholders determine how to track implementation progress over time and also provides the information necessary to complete a watershed management plan.

***E. coli* Goal Statement:** The waterbodies (or streams) in the South Fork Blue River watershed should meet the 235 colonies/100 mL (single sample max) TMDL target value.

***E. coli* Indicator:** Water quality monitoring by IDEM will serve as the environmental indicator to determine progress toward the *E. coli* target value.

7.3 Summary of Programs

There are a number of federal, state, and local programs that either require or can assist with the implementation activities recommended for the South Fork Blue River watershed in Table 34. A description of these programs is provided in this section. The following section discusses how some of these programs relate to the various sources in the South Fork Blue River watershed.

7.3.1 Federal Programs

Clean Water Act Section 319(h) Grants

Section 319 of the federal Clean Water Act contains provisions for the control of nonpoint source pollution. The Section 319 program provides for various voluntary projects throughout the state to prevent water pollution and also provides for assessment and management plans related to waterbodies in Indiana impacted by NPS pollution. The Watershed Planning and Restoration Section within the Watershed Assessment and Planning Branch of the Office of Water Quality administers the Section 319 program for the NPS-related projects.

USEPA offers Clean Water Act Section 319(h) grant monies to the state on an annual basis. These grants must be used to fund projects that address nonpoint source pollution issues. Some projects which the Office of Water Quality has funded with this money in the past include developing and implementing Watershed Management Plans (WMPs), BMP demonstrations, data management, educational programs, modeling, stream restoration, and riparian buffer establishment. Projects are usually two to three years in length. Section 319(h) grants are intended to be used for project start-up, not as a continuous funding source. Units of government, nonprofit groups, and universities in the state that have expertise in nonpoint source pollution problems are invited to submit Section 319(h) proposals to the Office of Water Quality.

Clean Water Action Section 205(j) Grants

Section 205(j) provides for planning activities relating to the improvement of water quality from nonpoint and point sources by making funding available to municipal and county governments, regional planning commissions, and other public organizations. For-profit entities, non-profit organizations, private associations, universities and individuals are not eligible for funding through Section 205(j). The CWA states that the grants are to be used for water quality management and planning, including, but not limited to:

- Identifying most cost effective and locally acceptable facility and non-point source measures to meet and maintain water quality standards;
- Developing an implementation plan to obtain state and local financial and regulatory commitments to implement measures developed under subparagraph A;
- Determining the nature, extent, and cause of water quality problems in various areas of the state.

The Section 205(j) program provides for projects that gather and map information on nonpoint and point source water pollution, develop recommendations for increasing the involvement of environmental and civic organizations in watershed planning and implementation activities, and develop watershed management plans.

Conservation Stewardship Program (CSP)

The Conservation Stewardship Program (CSP) helps landowners build on their existing conservation efforts while strengthening their operation. Whether they are looking to improve grazing conditions, increase crop yields, or develop wildlife habitat, NRCS can custom design a CSP plan to help them meet those goals. NRCS can help landowners schedule timely planting of cover crops, develop a grazing plan that will improve the forage base, implement no-till to reduce erosion or manage forested areas in a way that benefits wildlife habitat. If you landowners are already taking steps to improve the condition of the land, chances are CSP can help them find new ways to meet their goals.

USDA's Conservation Reserve Program (CRP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program administered by the USDA Farm Service Agency. The Conservation Reserve Program reduces soil erosion, protects the Nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost-share funding is provided to establish the vegetative cover practices.

USDA's Conservation Reserve Enhancement Program (CREP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program administered by the USDA Farm Service Agency. The Conservation Reserve Enhancement Program (CREP), an offshoot of CRP, targets high-priority conservation concerns identified by a State, and federal funds are supplemented with non-federal funds to address those concerns. In exchange for removing environmentally sensitive land from production and establishing permanent resource conserving plant species, farmers and ranchers are paid an annual rental rate along with other federal and state incentives as applicable per each CREP agreement. Participation is voluntary, and the contract period is typically 10–15 years.

USDA's Farmable Wetlands Program (FWP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program administered by the USDA Farm Service Agency. The Farmable Wetlands Program (FWP) is designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. FWP is a voluntary program to restore up to one million acres of farmable wetlands and associated buffers. Participants must agree to restore the wetlands, establish plant cover, and to not use enrolled land for commercial purposes. Plant cover may include plants that are partially submerged or specific types of trees.

By restoring farmable wetlands, FWP improves groundwater quality, helps trap and break down pollutants, prevents soil erosion, reduces downstream flood damage, and provides habitat for water birds and other wildlife. Wetlands can also be used to treat sewage and are found to be as effective as "high tech" methods.

The Farm Services Agency (FSA) runs the program through the Conservation Reserve Program (CRP) with assistance from other government agencies and local conservation groups.

USDA's Conservation Technical Assistance (CTA)

The purpose of the CTA program is to assist landusers, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. The purpose of the conservation systems is to reduce erosion, improve soil and water quality, improve and conserve wetlands, enhance fish and wildlife habitat, improve air quality, improve pasture and range condition, reduce upstream flooding, and improve woodlands.

One objective of the program is to assist individual land users, communities, conservation districts, and other units of State and local government and Federal agencies to meet their goals for resource stewardship and assist individuals in complying with State and local requirements. NRCS assistance to individuals is provided through conservation districts in accordance with the Memorandum of Understanding signed by the Secretary of Agriculture, the Governor of the State, and the conservation district. Assistance is provided to land users voluntarily applying conservation practices and to those who must comply with local or State laws and regulations.

Another objective is to provide assistance to agricultural producers to comply with the highly erodible land (HEL) and wetland (Swampbuster) provisions of the 1985 Food Security Act as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (16 U.S.C. 3801 et. seq.), the Federal Agriculture Improvement and Reform Act of 1996, and wetlands requirements of Section 404 of the Clean Water Act. NRCS makes HEL and wetland determinations and helps land users develop and implement conservation plans to comply with the law. The program also provides technical assistance to participants in USDA cost-share and conservation incentive programs.

NRCS collects, analyzes, interprets, displays, and disseminates information about the condition and trends of the Nation's soil and other natural resources so that people can make good decisions about resource use and about public policies for resource conservation. They also develop effective science-based technologies for natural resource assessment, management, and conservation.

USDA's Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program provides assistance to farmers and ranchers in complying with Federal, State, and tribal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation. The purposes of the program are achieved through the implementation of a conservation plan, which includes structural, vegetative, and land management practices on eligible land. Five to ten year contracts are made with eligible producers. Cost-share payments may be made to implement one or more eligible structural or vegetative practices, such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as nutrient management, pest management, and grazing land management.

Fifty percent of the funding available for the program is targeted at natural resource concerns relating to livestock production. The program is carried out primarily in priority areas that may be watersheds, regions, or multi-state areas, and for significant statewide natural resource concerns that are outside of geographic priority areas.

USDA's Watershed Surveys and Planning

The Watershed and Flood Prevention Act, P.L. 83-566, August 4, 1954, (16 U.S.C. 1001-1008) authorized this program. Prior to fiscal year 1996, small watershed planning activities and the cooperative river basin surveys and investigations authorized by Section 6 of the Act were operated as separate programs. The 1996 appropriations act combined the activities into a single program entitled the Watershed Surveys and Planning program. Activities under both programs are continuing under this authority.

The purpose of the program is to assist Federal, State, and local agencies and tribal governments to protect watersheds from damage caused by erosion, floodwater, and sediment and to conserve and develop water and land resources. Resource concerns addressed by the program include water quality, opportunities for water conservation, wetland and water storage capacity, agricultural drought problems, rural development, municipal and industrial water needs, upstream flood damages, and water needs for fish, wildlife, and forest-based industries.

Types of surveys and plans include watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance. The focus of these plans is to identify solutions that use land treatment and non-structural measures to solve resource problems.

Agricultural Conservation Easement Program (ACEP)

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps American Indian tribes, state and local governments and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands.

Agricultural Land Easements protect the long-term viability of the nation's food supply by preventing conversion of productive working lands to non-agricultural uses. Land protected by agricultural land easements provides additional public benefits, including environmental quality, historic preservation, wildlife habitat and protection of open space.

Wetland Reserve Easements provide habitat for fish and wildlife, including threatened and endangered species, improve water quality by filtering sediments and chemicals, reduce flooding, recharge groundwater, protect biological diversity and provide opportunities for educational, scientific and limited recreational activities.

NRCS provides financial assistance to eligible partners for purchasing Agricultural Land Easements that protect the agricultural use and conservation values of eligible land. In the case of working farms, the program helps farmers and ranchers keep their land in agriculture. The program also protects grazing uses and related conservation values by conserving grassland, including rangeland, pastureland and shrubland. Eligible partners include American Indian tribes, state and local governments and non-governmental organizations that have farmland, rangeland or grassland protection programs.

Under the Agricultural Land component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Where NRCS determines that grasslands of special environmental significance will be protected, NRCS may contribute up to 75 percent of the fair market value of the agricultural land easement.

Regional Conservation Partnership Program (RCPP)

The Regional Conservation Partnership Program (RCPP) encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife and related natural resources on regional or watershed scales. Through the program, NRCS and its partners help producers install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved.

Healthy Forests Reserve Program (HFRP)

The Healthy Forests Reserve Program (HFRP) helps landowners restore, enhance and protect forestland resources on private lands through easements and financial assistance. HRFP aids the recovery of endangered and threatened species under the Endangered Species Act, improves plant and animal biodiversity and enhances carbon sequestration.

HFRP provides landowners with 10-year restoration agreements and 30-year or permanent easements for specific conservation actions. For acreage owned by an Indian tribe, there is an additional enrollment option of a 30-year contract. Some landowners may avoid regulatory restrictions under the Endangered Species Act by restoring or improving habitat on their land for a specified period of time.

Conservation Innovation Grants (CIG)

Conservation Innovation Grants (CIG) are competitive grants that drive public and private sector innovation in resource conservation. Authorized by the 2002 Farm Bill, CIG uses Environmental Quality Incentives Program (EQIP) funds to award competitive grants to non-Federal governmental or nongovernmental organizations, American Indian Tribes, or individuals. Producers involved in CIG funded projects must be EQIP eligible.

Through the NRCS CIG program, public and private grantees develop the tools, technologies, and strategies to support next-generation conservation efforts on working lands and develop market-based solutions to resource challenges. Grantees leverage the federal investment by at least matching it.

The NRCS understands the importance of supporting historically underserved, new and beginning, and military veteran producers in farming and ranching because these producers are critical to the fabric of American agriculture and to our rural communities. Annually, approximately 10% of CIG funding is set aside to support these farmers and ranchers.

CIG projects inspire creative problem-solving that boosts production on farms, ranches, and private forests - ultimately they improve water quality, soil health, and wildlife habitat.

Voluntary Public Access and Habitat Incentive Program (VPA-HIP)

The Voluntary Public Access and Habitat Incentive Program (VPA-HIP) is a competitive grants program that helps state and tribal governments increase public access to private lands for wildlife-dependent recreation, such as hunting, fishing, nature watching or hiking.

State and tribal governments may submit proposals for VPA-HIP block grants from NRCS. These governments provide the funds to participating private landowners to initiate new or expand existing public access programs that enhance public access to areas previously unavailable for wildlife-dependent recreation. Nothing in VPA-HIP preempts liability laws that may apply to activities on any property related to grants made in this programs.

7.3.2 State Programs

State Point Source Control Program

The purpose of the NPDES permit is to control the point source discharge of pollutants into the waters of the State such that the quality of the water of the State is maintained in accordance with applicable water quality standards. NPDES permit requirements ensure that the minimum amount of control is imposed upon any new or existing point source through the application of technology-based treatment requirements. Control of discharges from WWTPs, industrial facilities and CSOs consistent with WLAs is implemented through the NPDES program. The Storm water and Sediment Control Program works primarily with developers, contractors, realtors, property holders and others to address erosion and sediment concerns on non-agricultural lands, especially those undergoing development.

State Nonpoint Source Control Program

The state's Nonpoint Source Program, administered by the IDEM Office of Water Quality's Watershed Planning and Restoration Section, focuses on the assessment and prevention of nonpoint source water pollution. The program also provides for education and outreach to improve the way land is managed. Through the use of federal funding for the installation of BMPs, the development of watershed management plans, and the implementation of watershed restoration pollution prevention activities, the program reaches out to citizens so that land is managed in such a way that less pollution is generated.

Nonpoint source projects funded through the Office of Water Quality are a combination of local, regional, and statewide efforts sponsored by various public and not-for-profit organizations. The emphasis of these projects has been on the local, voluntary implementation of nonpoint source water pollution controls. The

Watershed Planning and Restoration Section administers the Section 319 funding for nonpoint source-related projects, as well as Section 205(j) grants.

To award 319 grants, Watershed Planning and Restoration Section staff review proposals for minimum 319(h) eligibility criteria and rank each proposal. In their review, members consider such factors as: technical soundness; likelihood of achieving water quality results; strength of local partnerships; and competence/reliability of contracting agency. They then convene to discuss individual project merits and pool all rankings to arrive at final rankings for the projects. All proposals that rank above the funding target are included in the annual grant application to USEPA, with USEPA reserving the right to make final changes to the list. Actual funding depends on approval from USEPA and yearly congressional appropriations.

Section 205(j) projects are administered through grant agreements that define the tasks, schedule, and budget for the project. IDEM project manager's work closely with the project sponsors to help ensure that the project runs smoothly and the tasks of the grant agreement are fulfilled. Site visits are conducted at least quarterly to touch base on the project, provide guidance and technical assistance as needed, and to work with the grantee on any issues that arise to ensure a successful project closeout.

Indiana State Department of Agriculture Division of Soil Conservation

The Division of Soil Conservation's mission is to ensure the protection, wise use, and enhancement of Indiana's soil and water resources. The Division's employees are part of Indiana's Conservation Partnership, which includes the 92 soil and water conservation districts (SWCDs), the USDA Natural Resources Conservation Service, and the Purdue University Cooperative Extension Service. Working together, the partnership provides technical, educational, and financial assistance to citizens to solve erosion and sediment-related problems occurring on the land or impacting public waters.

The Division administers the Clean Water Indiana soil conservation and water quality protection program under guidelines established by the State Soil Conservation Board, primarily through the local SWCDs in direct service to landusers. The Division staff includes field-based resource specialists who work closely with landusers, assisting in the selection, design, and installation of practices to reduce soil erosion on agricultural land. The Storm water and Sediment Control Program works primarily with developers, contractors, realtors, property holders and others to address erosion and sediment concerns on non-agricultural lands, especially those undergoing development.

Indiana Department of Natural Resources, Division of Fish and Wildlife

The Lake and River Enhancement (LARE) program utilizes a watershed approach to reduce nonpoint source sediment and nutrient pollution of Indiana's and adjacent states' surface waters to a level that meets or surpasses state water quality standards. To accomplish this goal, LARE provides technical and financial assistance to local entities for qualifying projects that improve and maintain water quality in public access lakes, rivers, and streams.

State Revolving Fund (SRF) Loan Program

The SRF is a fixed rate, 20-year loan administered by the Indiana Finance Authority. The SRF provides low-interest loans to Indiana communities for projects that improve wastewater and drinking water infrastructure. The Program's mission is to provide eligible entities with the lowest interest rates possible on the financing of such projects while protecting public health and the environment. SRF also funds non-point source projects that are tied to a wastewater loan. Any project where there is an existing pollution abatement need is eligible for SRF funding.

Hoosier Riverwatch

Hoosier Riverwatch, administered by the IDEM OWQ Watershed Assessment and Planning Branch, is a water quality monitoring initiative which aims to increase public awareness of water quality issues and concerns through hands-on training of volunteers in-stream monitoring and cleanup activities. Hoosier Riverwatch collaborates with agencies and volunteers to educate local communities about the relationship between land use and water quality and to provide water quality information to citizens and governmental agencies working to protect Indiana's rivers and streams.

7.3.3 Local Programs

Programs taking place at the local level are key to successful TMDL implementation. Partners at the local level are instrumental to bringing grant funding into the South Fork Blue River watershed to support local protection and restoration projects. This section provides a brief summary of the local programs taking place in the South Fork Blue River watershed that will help to reduce *E. coli* loads, as well as provide ancillary benefits to the South Fork Blue River watershed.

Local SWCDs

The Washington County SWCD along with partners: (Indiana Department of Natural Resources, Indiana State Department of Agriculture, Natural Resources Conservation Service, Eastern High School FFA, Clark, Floyd, Harrison, and Scott County SWCDs, The Nature Conservancy, Town of New Pekin, Town of Palmyra, and West Washington High School FFA) are all partnering to develop a watershed management plan. The goal of the South Fork Blue River Watershed Project is to assess the condition of streams in the watershed to facilitate informed decisions about appropriate best management practices in the South Fork Blue River watershed. This goal will be accomplished by completing four tasks that include: developing a watershed management plan, performing a water quality study, receiving input from community residents and stakeholders, and educating the community on water quality and pollution. The water quality study baseline was completed by IDEM and monthly monitoring using Hoosier Riverwatch methods is being conducted by volunteers from Eastern and West Washington FFA high school programs. This data provides information on concerns and stressors within the watershed and aids in the identification of critical areas, both contributing to the development of the watershed management plan. The ultimate goal of the South Fork Blue River Watershed Project is to improve the water quality and habitat of the river through increased awareness, action, and attention that a watershed planning process will accomplish. Once the watershed management plan is complete and is approved by IDEM and EPA, the project will begin to implement the best management practices and strategies outlined in the plan until the goals are met. Funding for the first phase of implementation will be provided in part by a Section 319 grant, tentatively scheduled to begin in late 2017. The project will seek additional funding through local foundations, industries and grants as well as through USDA Farm Bill programs such as EQIP and CRP. Additionally, with the success of an education program and service activities, the project will continue holding field days and workshops as well as developing public relation materials that support the project. Funding for these activities may come from EPA grants, local and statewide grants, and/or local donations.

The Nature Conservancy (TNC)

The Nature Conservancy (TNC) is working with willing partners from landowners to county and city governments to improve how nutrients and sediments are assimilated back into the environment before they reach the Blue River. TNC has planted 640 acres of trees in the watershed, mostly as riparian and sinkhole buffers to shade the river. They have assisted the City of Salem's wastewater treatment plant to upgrade from a chemical treatment to ultraviolet system; eliminating the need for humans to handle chemicals and diverting these chemicals from the wastewater effluent.

The Nature Conservancy participates on the South Fork Blue River Watershed steering committee and has partnered with this group to learn about *E. coli* concerns in the South Fork. Because the South Fork and all of Blue River are karst-fed streams, the possibility of faulty septic systems is a concern as unmaintained septic systems don't back up into homes, but instead find cracks in the bedrock to discharge untreated waste. Animal feces directly or indirectly entering the South Fork is also a potential source of *E. coli*. Two sampling events for *E. coli* bacterial differentiation have shown that *E. coli* levels in the South Fork Blue River are at least somewhat attributable to human and ruminant (cattle, goats and sheep) sources. Despite the prevalence of poultry operations in the watershed, no samples have shown a trace of poultry-associated bacteria. This information will be included in the South Fork Blue River Watershed plan as it is a concern for the steering committee and community at large. In particular, agricultural producers have been interested to learn about whether their operations are contributory to the *E. coli* levels in the South Fork Blue River.

The Duke Energy Foundation, with matching funds from US Fish and Wildlife Service, granted TNC funds for mussel augmentation in the Blue River. Pregnant female wavy-rayed lampmussels, an Indiana species of special concern, were collected and their larvae were grown at the Center for Freshwater Mussel Conservation in Frankfort Kentucky. Progeny from these mussels were released into the Blue River in the fall of 2015 and 2016 to determine whether improved water quality in the Blue River will support young mussels that are more susceptible to pollution than adult mussels. The project also seeks to establish lab-rearing as a viable means of population augmentation for this and other freshwater mussel species in the Blue River. Filtering up to eight gallons of water a day, freshwater mussels are means of keeping Blue River even cleaner if their numbers can be boosted. Results from 2015 show 80% survival of juvenile mussels in suitable habitat areas of Blue River.

Bellarmine University

In the summer 2015, Bellarmine University conducted a water quality and macroinvertebrate study of the Blue River. Water chemistry showed significant differences in the upper and lower watershed. Temperatures in the lower watershed were significantly greater by 3.3 degrees C, on average, than the upper watershed sites. Alkalinity and pH were also significantly greater in the lower watershed. Turbidity and nitrate were substantially greater in the upper sites but due to variability in these data the differences were not significant. Specific conductance and dissolved oxygen showed no detectable difference in means. With the exception of Whiskey Run, which is a tributary to the main stem of the Blue River, the lower sites had larger upstream watersheds than the upper sites, as would be expected, which also indicates greater discharge in the lower watershed sites, as discharge is proportional to drainage area.

Mean macroinvertebrate abundance (total number of organisms observed) in the lower watershed was more than double the upper mean and was significantly different. Family-level richness (number of families observed) was also significantly greater in the lower watershed, with five more families observed, on average, in the lower watershed than the upper. No detectable differences were observed in the mIBI (macroinvertebrate index of biological integrity) or EPT/C (ratio of Ephemeroptera, Plecoptera, and Trichoptera to chironomid abundance), however both mean values (mIBI and EPT/C) were greater in the lower watershed.

Local habitat was of significantly higher quality in the lower watershed. No detectable difference in mean percentage of the watershed occupied by developed land cover was observed between the upper and lower sites. However, forested land cover was significantly greater in the lower watershed, whereas agricultural land cover was more prominent in the upper sites. Lastly, wetland types were evenly distributed throughout the watershed and did not show detectable differences between the upper and lower site means.

These studies and experiments in the Blue River help to understand where TNC and partners can direct efforts to improve water and habitat quality. In the upper watershed, conservation has a trickle-down effect, where improvements in sediment or nutrients benefits the entire river. Species augmentations, in the Blue River such as mussels and hellbenders will be enhanced with increased conservation practices in the upper Blue River watershed.

The Indiana Karst Conservancy (IKC)

The Indiana Karst Conservancy is a 501(c)(3) non-profit organization dedicated to the preservation and conservation of Indiana's unique karst features. The IKC was formed by concerned individuals when it became apparent that no similar group was actively protecting such features for their inherent geological, biological, and historical importance.

The purposes of the IKC are the management, protection, and acquisition of the karst areas in southern Indiana. The IKC also supports research and promotes education related to karst and its appropriate use. Many of today's abuses in karst areas arise from lack of understanding and knowledge.

To advance these goals, the IKC sponsors or participates in a number of activities. The IKC:

- Organized and hosted the 1995 National Cave Management Symposium at Spring Mill State Park.
- With the Indiana Cave Survey, sponsors the Indiana Cave Symposium; an opportunity for local cavers to share their projects with others.
- Maintains cooperative relationships with several state and federal agencies; influencing management plans and decision-making for Indiana karst on public lands.
- Participates in a biennial census of the federally-endangered Indiana bat (Myotis sodalis). Temperature monitoring devices are installed in the larger Indiana bat hibernacula to correlate temperatures to populations.
- Manages caves containing the threatened troglobitic species such as blind fish, crayfish and the Indiana bat. Populations are monitored on a periodic basis.
- Sponsors Under-Earth Day, an annual cleanup/workday on one of our nature preserves.
- Reprints scholarly and historical publications relating to caves and karst in Indiana.

- Provides, free of charge, karst-related slide presentations and question-and-answer sessions for interested groups.engages in cave and mine gating projects, where absolutely necessary. Gates are designed to avoid restricting the passage of air, cave life and organic matter.
- Responds to industrial or residential developments or other activities that may endanger caves.

7.4 Implementation Programs by Source

Section 0 identified a number of federal, state, and local programs that can support implementation of the recommended management or restoration activities for the South Fork Blue River watershed. Table 35 and the following sections identify which programs are relevant to the various sources in the South Fork Blue River watershed.

Table 35: Summary of Programs Relevant to Sources in the South Fork Blue River Watershed

Source	State NPDES program	Local agencies/programs	Section 319 program	Section 205(j) program	ISDA Division of Soil Conservation	IDNR Division of Fish and Wildlife	USDA's Conservation Stewardship Program	USDA's Conservation Reserve Program	USDA's Conservation Technical Assistance	USDA's Environmental Quality Incentives Program	USDA's Small Watershed Program and Flood Prevention Program	USDA's Watershed Surveys and Planning	USDA's Farmable Wetlands Program	USDA's Conservation Innovation Grant	USDA's Healthy Forests Program
WWTPs and Industrial Facilities	X			X											
Regulated Storm water Sources	X			X											
Illicitly Connected "Straight Pipe" Systems	X	X		X											
Cropland		X	X	X	X	X	X	X	X	X	X	X	X	X	
Pastures and Livestock Operations		X	X	X	X	X	X	X	X	X	X	X		X	
CFOs	X			X			X							X	
Streambank Erosion		X	X	X	X	X	X	X	X	X	X	X		X	X
Onsite Wastewater Treatment Systems		X		X											
Wildlife/Domestic Pets		X	X												X
In-stream Habitat		X	X											X	X

7.4.1 Point Source Programs

WWTPs

Discharges from WWTPs are regulated under the NPDES program, with permits that authorize the discharge of substances at levels that meet the more stringent of technology- or water quality-based effluent limits. The NPDES program provides IDEM the authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the watershed. IDEM has begun implementing a TMDL WLA tracking system that will assist NPDES permit writers to accurately reflect the assumptions in the TMDL into the next permit cycle. TMDL staff have also begun meeting quarterly with permits staff to ensure good communication of changes and updates throughout the TMDL development and permit renewal process.

Illegal straight pipes

Local health departments are responsible for locating and eliminating illicit discharges and illegal connections to the sewer system.

7.4.2 Nonpoint Sources Programs

Cropland

Nonpoint source pollution from cropland areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of cropland BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs
- USDA's Conservation Reserve Program (CRP)
- USDA's Conservation Reserve Enhancement Program (CREP)
- USDA's Conservation Technical Assistance (CTA)
- USDA's Farmable Wetlands Program (FWP)
- USDA's Environmental Quality Incentives Program (EQIP)

Pastures and livestock operations

Nonpoint source pollution from pasture and livestock areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of pasture and grazing BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs
- USDA's Conservation Reserve Program (CRP)
- USDA's Conservation Reserve Enhancement Program (CREP)
- USDA's Farmable Wetlands Program (FWP)
- USDA's Conservation Technical Assistance (CTA)
- USDA's Environmental Quality Incentives Program (EQIP)
- USDA's Watershed Surveys and Planning

CFOs

While CAFOs are regulated by federal law, CFOs are not. However, Indiana has CFO regulations 327 IAC 16, 327 IAC 15 that require that operations manage manure, litter, and process wastewater in a manner that "does not cause or contribute to an impairment of surface waters of the state." IDEM regulates CFOs under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 16, which implement the statute regulating CFOs, were effective on March 10, 2002. IDEM's Office of Land Quality administers the regulatory program, which includes permitting, compliance monitoring and enforcement activities.

Indiana law directed the Office of Indiana State Chemist (OISC) to develop a rule to ensure that fertilizer materials are distributed and used effectively and safely as plant nutrients and in a manner that protects water quality. Rule went in effect February 16, 2013. A written application plan is required by all growers who use at least 10 cubic yards or 4,000 gallons of any type of fertilizer material. Manure can't be applied to HEL unless there is at least 40 percent crop residue or a vegetative cover crop. CFOs cannot apply manure to frozen ground unless special permission has been granted by IDEM. Additional organic manure staging requirements include:

- Stage 300 feet away from surface water, water well, drainage inlets (risers in field)
- Cannot stage in a waterway, floodway, or standing water
- Cover, or berm, pile after 72 hours
- Stage 100 feet from property line or public road
- Stage 400 feet from residential buildings
- Do not stage on an area of greater than 6% slope unless gradient barrier
- Do not stage on the side of a hill
- Apply to field within 90 days

Streambank erosion

Streambank erosion can be the result of changes in the physical structure of the immediate bank from activities such as removal of riparian vegetation or frequent use by livestock, or it can be the result of increased flow volumes and velocities resulting from increased surface runoff throughout the upstream watershed. Therefore, streambank erosion might be addressed through BMPs and restoration targeted to the specific stream reach, and further degradation could be addressed through the use of BMPs implemented to address storm water issues throughout the watershed. Programs available to support implementation of BMPs to address streambank erosion, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Agriculture Division of Soil Conservation
- USDA's Conservation Technical Assistance (CTA)
- USDA's Environmental Quality Incentives Program (EQIP)
- USDA's Watershed Surveys and Planning

Onsite wastewater treatment systems

Indiana State Department of Health (ISDH) Rule 410 IAC 6-8.1 outlines regulations for septic systems, including a series of regulatory constraints on the location and design of current septic systems in an effort to prevent system failures. The rule prohibits failing systems, requiring that:

- No system will contaminate ground water.
- No system will discharge untreated effluent to the surface.

Wildlife/domestic pets

Addressing pollutant contributions from wildlife and domestic pets is typically done at the local level through education and outreach efforts. For wildlife, educational programs focus on proper maintenance of riparian areas and discouraging the public from feeding wildlife. For domestic pets, education programs focus on responsible pet waste maintenance (e.g., scoop the poop campaigns) coupled with local ordinances.

7.5 Potential Implementation Partners and Technical Assistance Resources

Agencies and organizations at the federal, state, and local levels will play a critical role in implementation to achieve the WLAs and LAs assigned under this TMDL. Table 36 identifies key potential implementation partners and the type of technical assistance they can provide to watershed stakeholders.

Table 36: Potential Implementation Partners in the South Fork Blue River Watershed

Potential Implementation Partner	Funding Source
Federal	
USDA	Conservation of Private Grazing Land Initiative (technical and education assistance only)
USDA	Conservation Reserve Program
USDA	Conservation Technical Assistance (technical assistance only)
USDA	Environmental Quality Incentives Program
USDA	Small Watershed Program and Flood Prevention Program
USDA	Watershed Surveys and Planning
USDA	Wildlife Habitat Incentives Program
State	
ISDA	Division of Soil Conservation
ISDA	Clean Water Indiana
IDNR	Division of Fish and Wildlife Lake and River Enhancement program
IDEM	Section 319 program grants
IDEM	Section 205(j) program grants
Local	
Soil and Water Conservation Districts	
Indiana Karst Conservancy	501(c)(3) non-profit organization
The Nature Conservancy	501(c)(3) non-profit organization
Bellarmine University	

IDEM has compiled a matrix of public and private grants and other funding resources available to fund watershed implementation activities. The matrix is available on IDEM's website at http://www.in.gov/idem/nps/3439.htm.

8.0 Public Participation

Public participation is an important and required component of the TMDL development process. The following public meetings were held in the watershed to discuss this project:

- Two meetings were held at the Palmyra United Methodist Church and Pekin Shelter House on 11-18-2014 during which IDEM and Washington County SWCD described the TMDL program and provided a summary of the available data and the proposed modeling approach. Information was also solicited from stakeholders in the area.

- On 7-12-2016, the South Fork-Blue River Watershed Project teamed up with the Indiana Department of Environmental Management (IDEM) to host a water monitoring demonstration. The event was held on Dutch Creek at the property of David and Theresa Gottbrath in Pekin IDEM staff were on site to explain and/or give demonstrations on their process for collecting water chemistry, fish through electrofishing techniques, and macroinvertebrates. Results were discussed for the 2014-2015 IDEM sampling of the watershed. The details of the partnership between the Washington County SWCD and IDEM were detailed as well. The Nature Conservancy, Purdue University, and Bellarmine University were also in attendance to share their projects within the watershed.

- One Draft TMDL meeting was held at the Palmyra Senior/Community Center on July 27, 2017 during which IDEM described the TMDL program and provided an overview of the draft TMDL results. The draft findings of the TMDL will be presented at these meetings and the public will have the opportunity ask questions and provide information to be included in the final TMDL report. A public comment period was from July 7, 2017 to August 7, 2017.

Works Cited

1 EPA, "An Approach for Using Load Duration Curves in the Development of TMDLs," 2007.

2 IDEM, "Nonpoint Source Water Pollution," 30 December 2010. [Online]. Available: https://secure.in.gov/idem/nps/2422.htm. [Accessed 21 January 2016].

3 Homer, "Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information," *Photogrammetric Engineering and Remote Sensing*, vol. 81, no. 5, pp. 345-354, 2015.

4 Horsely and Witten Inc (1992) Groundwater hydrology, contamination and management. Final Report on the Demonstration Project conducted on Molokai, Hawaii, Horsely and Witten, Sandwich, MA

5 IDNR, "List of Endangered, Threatened, and Rare Species by County," Indiana Goverment , April 2013. [Online]. Available: http://www.in.gov/dnr/naturepreserve/4666.htm. [Accessed 22 January 2016].

6 "USDA National Agricultural Statistics Service Cropland Data Layer," https://nassgeodata.gmu.edu/CropScape, USDA-NASS, Washington, DC., 2012.

7 USDA Census of Agriculture, 2012. [Online]. Available: https://agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Indiana/st18_2_001_001.pdf.

8 Judy D. Fretweil, "National Water Summary on Wetland Resources: Water Supply Paper 2425," USGS, 1996.

9 American Veterinary Medical Association, "U.S Pet Ownership and Demographics Sourcebook," AVMA, New York, 2012.

APPENDIX A. WATER QUALITY DATA FOR THE SOUTH FORK BLUE RIVER WATERSHED TMDL

APPENDIX B. REASSESSMENT NOTES FOR THE SOUTH FORK BLUE RIVER WATERSHED TMDL

APPENDIX C. SAMPLING AND ANALYSIS WORK PLAN